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VIEWS, NEWS AND INTERVIEWS.

The truly gifted engineer always makes one part of his work fit into another, and no energy is ever wasted, says an exchange. A wealthy engineer who had set up a very fine place in the country, where he had carried out many pet constructive projects, was visited there by an old friend.

The visitor had so much difficulty in pushing open his front gate that he spoke about it to the proprietor.

"You ought to fix that gate," said the guest. "A man who has everything 'just so' should not have a gate that is hard to open."

"Ha!" exclaimed the engineer, "you don't understand my economy. That gate communicates with the waterworks of the house, and every person who comes through it pumps up four gallons of water."

Mr. Brayton Ives, of New York city, chairman of the Executive Committee of the Westinghouse Electric and Manufacturing Company, last week bought for $1,000 a fine park horse called "X Ray."

Walter K. Freeman, the electrical engineer who has achieved notoriety in many ways, has had another unusual experience. He is on trial in New York city for seduction, and makes his residence in the Tombs. One day last week, while taking walking exercise in one of the jail corridors, Freeman's pocket was picked of his watch. It was found in the possession of one Smith, awaiting trial for burglary. Freeman's experience brings to mind the old story of the convict in Sing Sing who couldn't find his cap. He went to Principal Keeper Connaughton and exclaimed, "Mr. Connaughton, there are thieves in this prison!"

This story of the late Sir Andrew Clark, the English physician, is told by a writer in *Cassell's Magazine*. "Two years ago the son of a wealthy nobleman lay in San Francisco suffering from typhoid fever. His friends longed to obtain the advice of the great English physician, but Sir Andrew could not be brought over in time. Nevertheless, his aid was obtained. The famous doctor went to the London end of the cable; the other end was laid into the sick room in California. Thus a consultation was held under the sea between the English medical authority and his American colleagues, the very beat of the sufferer's pulse being registered from time to time, thousands of miles away. The lad recovered."

Russia is to have an electrical branch of her army, under a lieutenant general, two major-generals and five officers of lower grade, who will also have a military electrical school under their charge. Russian military officers have always been adept in the use of electricity.

"We don't want any X-ray jokes," said the editor of an exchange.

"Very well," said the humorist; "we will return it to the package and produce the joke about the X-ray joke. Ah, that is played out, too? Then permit me to show you my newest joke about the joke about the X-ray joke, and if that will not do I still have in reserve——"

He got the quarter.

A New Scale Wire Bridge.

The Buffalo Instrument Company, of Buffalo, N. Y., are the manufacturers of the portable scale wire bridge illustrated herewith. A general view of the instrument, which is claimed to be an entirely new departure, is given in Fig. 1. The diagram of connections is shown in Fig. 2. The bridge is contained in a mahogany case separate from the batteries. There is but one plug to the bridge, which reduces the liability of variable resistance through bad contact of plugs to a minimum.

Fig. 2.—Diagram of Connections, Scale Wire Bridge.

Fig. 1.—A New Scale Wire Bridge.

The variable resistance of the bridge is composed of a continuous scale wire, 500 inches in length, stretched around suitable insulated pins at the end of a table. Under the table is a chart divided into 1,000 half inches; each half inch is divided into 10 degrees, which virtually divides the scale wire into 10,000 separate units or degrees. The chart facilitates reading the scale in making measurements.

The standards of resistance or multipliers of the bridge are 1 ohm, 10 ohms, 1,000 ohms and 10,000 ohms, respectively. The standards are calibrated to embrace one-half of the scale wire, 5,000 units or degrees of the scale (from A to B, Fig. 2), while the other side of the coils is connected to multiplier post D. The standard would be from letter B to A to D. The unknown is across the remaining leg of the diagram (from D to XX).

One side of the receiver or galvanometer is connected to D, the other side being at C, which is a finder or contact to be used in tracing the neutral point over the scale, between XX to B and A. The battery connects between points A and XX.

To find the neutral point, the finder or pointer C is drawn over the manifolds of the "scale wires." It is readily determined on which wire the neutral point lies, as the receiver indicates a sharp, loud sound, except when at the neutral point or close to it, when it becomes weaker and finally is silent at the neutral point. Readings taken with this style of receiver have proved to be fully as sensitive as with the ordinary galvanometer, and in many instances much closer results have been obtained with it. The chart under the scale wire gives the degree of the scale.

This style of instrument is so simple that no adjustment of the instrument is necessary before it is ready for use.

The Central Union Telephone Company will shortly issue $1,600,000 bonds. The company has a large floating indebtedness, and one-half of the bond issue will be used in payment to the American Bell Telephone Company in discharge of the latter company's account against the Central Union. The other $800,000 of the bonds will be offered to stockholders at 97½ on the basis of $100 in bonds for every four shares of stock.

tricity it contains it cannot by any external power or force. This can only be done by or through the means of magnetism, when our energy is applied in the form of power.

The machine that is constructed for the purpose of mechanically wrapping magnetism about or around the conducting wire is called a *dynamo*

FIG. 2.—NEW KNIGHT ARC LAMP.

by the electrician, and in doing so it consumes power in the same ratio that the current is allowed to flow through the wire, plus the friction or loss in heat. The battery puts the electricity in a wire circuit in motion by means of chemical action. One of the results of chemical action is electrical pressure, and if a wire is connected to a part of a battery that is under electrical pressure, and be continued even for a great distance, any point in this wire will be found to be under electrical pressure. If this wire is returned to the battery and connected to the part of it that is negative, or has a tendency to an electrical vacuum, then a current will flow as long as the chemical action continues in the battery.

The electric current generated by the dynamo is in all respects like the current generated by a battery; that is, a continuous dynamic current is identical with a battery current. The distant telegraphic instrument then by the proper remodeling becomes a machine that will take power from a passing current, and the part that only vibrated in telegraphy is placed on axles, and revolves when a current is passing through it. The instrument in this shape is called a *motor* by the electrician.

(To be continued.)

Desires Light on X Rays—Will Some Manufacturer Kindly Answer?

TO THE EDITOR OF ELECTRICAL REVIEW:

I am desirous of obtaining a little information regarding the X rays and do not know where to apply for it except to you, as I understand that your publication is at the head of everything in the electrical line. What I wish to know is how large a spark an induction coil is obliged to give in order to successfully work a Crookes tube in experimenting with the X rays; also, if the Crookes tubes are furnished in various sizes, and how small an induction coil and Crookes tube can be used that will demonstrate that the X rays exist.

G. E. S.

Towanda, Pa., April 16.

THE DIEHL MANUFACTURING COMPANY.

IMPROVED LINE OF MANUFACTURE BY THIS PROGRESSIVE COMPANY.

Coincident with the incorporation of the Diehl Manufacturing Company, of Elizabethport, N. J., and New York, and the addition of the word "Manufacturing" to the name, a new line of handsome Knight arc

FIG. 3.—NEW DIEHL CEILING FAN, VENETIAN DESIGN.

lamps, in a variety of styles, and the improved Diehl dynamos and motors will be placed on the market. At the present time the company's facilities at Elizabethport are taxed to the utmost for the production of Diehl electric fans, which have been long and so favorably known that it is said more than 11,000 of the suspended fans alone are in use.

FIG. 4.—DIEHL BALANCE WHEEL MOTOR APPLIED TO SEWING MACHINE.

Of these fans the company this year is making new and beautiful designs in venetian, polished brass and nickel and variously ornamented styles, the important feature being, moreover, that a material decrease in the amount of power required has been made. The self-oiling motors in these fans are directly coupled to the fan shafts and operate on any direct-current circuit or work successfully in series on arc and street railway circuits.

The illustration, Fig. 1, is a reproduction from a photograph of a Diehl dynamo directly connected to a Case engine. This installation is on board the steam yacht "Reverie," owned by the president of the Singer Manufacturing Company.

These machines have the armature encircling and revolving around the field magnets, which results in high efficiency, great durability and slow speed, avoiding the method of countershafting and the loss of power it incurs. This slower speed, being due to the large diameter of the armature, is obtained without increase of weight and gives a starting torque proportionately great, at the same time increasing the efficiency by a diminution of friction of the bearings and the brushes. The motors are fitted with self-aligning and self-oiling bearings and approved brush-holders, thereby requiring a minimum of attention.

The illustration, Fig. 2, of the new Knight arc lamp hardly does justice to the elaborate line which the Diehl company are preparing, and for the outdoor lamp the company has perfected a design which will be water-proof without the use of a hood. The important feature which will recommend the Knight lamp is that the striking magnet is composed of a few turns of heavy wire placed in the main circuit, and, when the current is on, this magnet is energized and pulls down the core of the shunt armature, holding the core in this position until it is weakened by the lengthening arc, then the core of the shunt magnet is released and it goes up to the feeding point. The armature is then practically out-field of the striking magnet and the arc depends entirely on the shunt magnets for regulation. This avoids the defect usual in the shunt lamp of not striking a proper arc when current is turned on. The adjustable chuck carbon-holders take in any size of carbon from one-fourth of an inch to five-eighths of an inch in diameter. The clutch wheel is used, requiring no dashpot nor main magnets. The clutch is applied to the periphery of the wheel; therefore the rod is less liable to stick when dirty than in a lamp with clutch working directly on the rod.

Since the incorporation of the company these officers have been elected: E. H. Bennett, Jr., president; Philip Diehl, vice-president; H. S. Miller, secretary, and J. A. Reid, treasurer. John C. Knight, prominently known in connection with the arc lamp industry, will superintend the lamp making. The New York office will be at 561 Broadway, under the management of C. A. Bramhall.

M. T. Lindenberg will be in charge of the Boston branch, at 128 Essex street.

President Bennett informed a representative of the ELECTRICAL REVIEW that the company were now increasing their facilities by the installation of many thousand dollars worth of new machinery, and it is fair to presume that the Diehl Manufacturing Company will, in the near future, be in the front rank as a manufacturing company.

The illustration, Fig. 4, shows the balance-wheel motor, as applied to the shaft of sewing machines. The motor is self-contained and the field magnets are attached to the shaft of the machine for connection with the current. The armature carrier acts as a balance wheel and is secured to the shaft by the clamp-stock motion. The speed is manipulated by a small brake and rheostat operated by treadle.

Safety Insulated Wire and Cable Company.

The Safety Insulated Wire and Cable Company, of New York city, last week closed a contract amounting to about $125,000, to furnish all the underground cables required by the Boston, Mass., Electric Light Company during the current year. This is a renewal of a similar contract made in 1895, which was obtained on the strength of the showing made by Safety cables in 1894.

A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS.

READ BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, NEW YORK, MARCH 25, 1896, BY WILLIAM L. PUFFER.

(Concluded from page 192.)

Early in November last the subject was again taken up, with the very efficient aid of Mr. R. E. Lawrence, a post-graduate student in electrical engineering at the Massachusetts Institute of Technology, and rapidly developed with such beautiful results that it was decided to exhibit publicly before the Society of Arts, which was done some little while after, at the regular meeting of January 2, 1896.

We first attempted to take a set of instantaneous photographs of the arc at different periods of an alternation, and by the use of a pneumatic shutter, and a progressive motion of the lens, obtained some very sharply defined pictures. After many trials, this was given up, because of the practical impossibility of timing the exposures with respect to the alternations, and we decided to use a disk with half as many slots as there were pole-pieces on the dynamo, and to drive it by the shaft of the machine itself.

The dynamo available was one giving a three-phase, 500-volt current with a frequency of about 60 cycles. Two wires only were used to give us the current required.

A somewhat long, light shaft, carrying at one end the disk, and at the other a positive mechanical clutch, was mounted in line with the armature shaft. As the clutch could only be thrown in when the two shafts were nearly equal in speed, a small motor was placed so as to bring the disk up to speed when the clutch was thrown in and the motor belt removed.

The disk was held in place by a frictional clamp disk on the shaft. A graduation and reference mark served to measure angular change of disk on shaft, and therefore of slots with reference to the pole-pieces or alternation of the current.

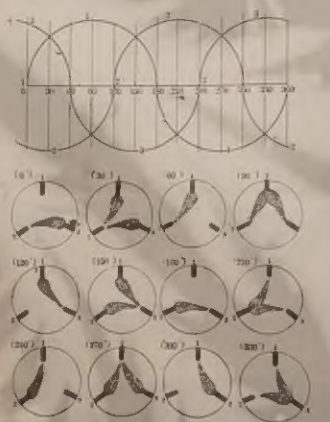
The arc to be tested was put in a boxing to keep away air from the currents close behind the disk, and a camera with a roll-holder in front of the disk. With this arrangement the arc as seen was perfectly steady at any part of the wave that corresponded to the position of the disk on the shaft, and, as the process of stopping, setting, and starting the disk was very rapid, the roll-holder being in meantime turned, many pictures could be taken in a very few minutes.

Generally, it was not necessary to take more than 12 exposures in order to get a series showing clearly the changes in light intensities during a single phase.

We found that it was about as instructive to watch the appearance of the arc on the ground glass of the camera, and far more beautiful. In this way we examined both the effect produced in the arc by change in the voltage of the circuit, the current being kept constant by alteration of the resistance.

For example, with 500 volts, and a large non-inductive resistance in series with the arc, it was plainly evident that the current wave was approximately sinusoidal, as the time of extinction of the current, as indicated by the blue band of the arc proper, was very short, and the rise and fall of the current gradual and with no irregularities. This is to be expected, as the back electro-motive force of the arc is small compared to the voltage of the generator, and the circuit as a whole is non-inductive.

The opposite condition was realized by using a lower electro-motive force and regulating by a reactive coil. The time of no current was longer, and the current appeared to jump to its maximum in an exceedingly small angular time. In this case the arc was not steady, showing clearly to the eye that the succeeding waves of current were not alike either in form or current value, and also that the angle of lag was constantly changing. This fact has always prevented an accurate plotting of wave forms by the instantaneous contact



A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS.

method, and although known to exist, was never before actually seen.

A very pretty double arc was arranged by using three carbons and wiring two circuits, each with current regulators, in such a way that the arc was the common junction, and one carbon was of one polarity, while the other two were of opposite polarity. With wire resistances in each side, there was nothing peculiar to be noted other than the effects of the junction of two currents, but when the resistance in one circuit was gradually cut out, and equivalent inductance cut in, there was at once visible evidence of the lag of the current, together with the change of shape of the wave and the unsteadiness before noted. Owing to the long time of no current in the inductive side, there were times when, even with considerable lag, there were actually no visible traces of current between either points. This effect was dependent on adjustment of current strength and inductance as well as voltage. The sequence of currents and polarity in this arc was most beautifully brought out when the disk was disengaged from the shaft, and driven by the little motor at a rate very slightly less than the dynamo.

We found that work in the immediate vicinity of the dynamo was not very desirable, owing to air currents and excessive vibration, so we arranged a combination of motors that will produce at any distance from the dynamo all the desired results.

A very nicely balanced brass disk with four radial slots in it was attached to the armature shaft of a Holtzer-Cabot synchronous induction motor of eight poles. The pulley of this motor could be driven by a light belt from a self-starting induction motor of the same make, which is, however, not quite synchronous under load. By trial the two pulleys are wound with rubber tape until their ratio is such that the brass disk will be unistantly seen as fixed; the belt is thrown off or left on, as desired. These armatures may be on the same shaft, if necessary. The synchronous motor does not stand on its base, but rests on the turned outside of its bearings in pillow blocks, which are attached to a suitable base frame.

Concentric with the shaft and firmly attached to the motor is a brass gear, six inches in diameter, and on it a graduated circle. On a lever pivoted so as to be thrown to or from the motor gear is a small spur gear with a milled head for turning.

Turning this head will evidently cause the motor to slowly rotate about its axle, and as the armature must be in step with the dynamo, and, as the turning of the motor changes the position of a given pole-piece relatively to the arc light, it follows that any part of the alternation of current in the arc may be seen on the screen, and as the motor has eight poles, a quarter turn or 90 degrees on the graduated circle corresponds to a complete cycle in the arc.

The picture of the arc can then be photographed, measured, or in any way studied at leisure in any phase relation, as, for example, when the top carbon is positive, or when there is no arc at all and only dull red carbon points visible.

In this way we have seen single arcs of high and low electro-motive force, long and short double arcs, arcs with much inductance in circuit, Jablochkoff candles, arc between a ring and a point within, the spinning arc between the ends of a carbon cylinder and a concentric carbon within, with a magnetizing coil around the inner carbon and the like.

One of the most beautiful arcs investigated by us visually and photographically was a rotary arc made by the use of three carbons in the same plane, at angles of 120 degrees apart and wired up as the junction point of an external Y load on a 500-volt, 60 cycle, three-phase generator. Non-inductive resistance was used in the circuit, and the current used in one leg of the Y was 10 or 15 amperes.

Twelve photographs were taken at equal intervals of 30 degrees in an alternation of the current in one wire. Fig. 1 shows very clearly the relation of the current waves from the different carbon points, and the curved, fan-shaped figure indicates the position and direction of the bluish arc at the corresponding angle. The base of the fan rests on a positive carbon, which has a white-hot crater and all the appearance of the positive carbon of a direct-current arc, while the tip of the fan rests on the white spot at the end of a negative carbon.

It will be seen at 0 degrees, for example, that there is no current on carbon 1 and that 2 is negative and 3 positive, the blue, fan-like arc curving from 3 to 2; 30 degrees later, 2 is still negative and 3 positive, but that an equal arc is now playing from 1 to 2. At 60 degrees 2 is still negative, 1 positive, but there is no current on 3. At 90 degrees the appearance is somewhat like 30 degrees, except that the signs are changed, and the point with the double current is necessarily much whiter, it being now positive. And so on through the changes of the complete wave.

This three-phase arc, when seen while the disk is running non-synchronously, is the most beautiful of any studied, and may be seen according to the different length of arc and the divergence of the disk from exact synchronism, either as a band of blue light, which seems to be progressively traveling over the three sides of a triangular path, or as a rapidly spinning star of blue light, being in fact a rotary arc.

The three phase arc is less noisy than the single-phase, and its light is steadier and has less variation in its total intensity, owing to the fact that the current never stops, and there is always a positive carbon. Three-cored carbons, placed parallel side by side, with slight magnetizing coils to keep the arc at the ends of the carbon, will give a very satisfactory light in the direction away from the tips, and may be used when it is desirable to throw all the light in one direction.

Four carbons, at 90 degrees apart, each with a suitable resistance in series with it, and connected to quarter-phase tap wires on a Gramme ring or other generator giving quarter-phase circuits, will also produce a rotary field arc of great beauty and interest.

Study of these arcs is still going on at the Institute of Technology under my immediate charge, which will, I hope, produce results sufficiently interesting to justify a second paper at some later date.

McClure's Magazine for May will have an article by the eminent surgeon, Dr. W. W. Keen, indicating the uses already possible, as well as those likely to become possible soon, of the Roentgen rays in the study and cure of human deformities, injuries, and diseases. The article will be fully illustrated from photographs taken by the new process.

ROENTGEN RAY DIFFUSION AND OPALESCENCE*—A NOVEL PHENOMENON.

BY ELIHU THOMSON.

So far as the writer is aware, the phenomena presently to be described have not hitherto been alluded to by writers or experimenters on Roentgen rays. They are the phenomena of diffusion of Roentgen rays by certain classes of substances in such a way that such substances must be regarded as opalescent or to act like opal glass with respect to ordinary light, or like milky liquids exhibiting diffusion of light from the interior and exterior of the mass.

Some substances are found to behave with Roentgen rays like compacted snow or translucent ice in diffusing light.

Let a large metal screen, such as a brass or iron plate, of one-sixteenth

FIG. 1.—NOTCHING PRESS WITH CLAMPING ARM, SHOWING RACK AND PINION MECHANISM.

FIG. 2.—NOTCHING PRESS WITHOUT CLAMPING ARM, SHOWING AUTOMATIC STOP.

to one-eighth inch in thickness, be suspended in a vertical place about a foot or more from a Crookes tube kept in action and emitting Roentgen rays toward the plate. On the side of the plate opposite to that next the Crookes tube there will, of course, be a shadow space free from Roentgen rays. While this statement is true in the abstract, it may easily happen that an exploration with a fluorescent screen tube or fluoroscope back of the metal plate will show that the rays are not absent, but appear to come around the edge of the plate. This phenomenon has been alluded to by Mr. Edison, and used in support of his supposition that the rays are high-pitch sound.

But on close examination it will be found that the rays back of the metal shield are, mainly, at least, due to diffusion from surrounding objects—the walls or floor of the room, or objects receiving the rays and scattering them.

Further examination will disclose the fact that bodies differ greatly in their diffusive power, and that substances, such as paraffine, wood, paper, pine, rubber, cloth of cotton, or wool, the hand of the experimenter, etc., which are tolerably transparent to the rays, are also energetic in diffusing them. That the diffusion is not merely from the surface, and not simply diffuse reflection, is shown by the fact that the rays come also from the back of the object and from portions not exposed directly to the rays. This indicates a true opalescence, like that possessed by opal glass in ordinary light. The inference may readily be drawn from this that the shadows of opaque objects embedded in tissue at considerable depths can never be as sharp or black, so to speak, as when the objects are merely surrounded by air. Liquids appear to possess the property as well as solids. It must be borne in mind, also, that the diffusion appears to take place in all directions, within and without the mass of the substance. If the fluorescent screen tube used have thick metal sides, the large metal plate can be dispensed with. In this case it suffices that the screen tube be turned at right angles to the path of the rays or to direct it away from the Crookes tube in a line at an angle with the course of the rays. Pieces of various substances may now be placed opposite to the end of the screen tube, but in a position to be partially or wholly exposed to the Roentgen rays. The pieces will become virtual sources of rays, and the diffused rays reaching the fluorescent screen will cause it to emit light.

By placing two exactly similar fluorescent screens at opposite ends of a dark tube, and employing a Bunsen photometer screen movable between them, a comparison of diffusing power of pieces of different materials might easily be made by subjecting the materials placed at the ends of the tube, respectively, to equal radiation from the Crookes tube. In fact, the relative effectiveness of two Crookes tubes as producers of the rays could be tested by such a "fluorometer" by passing the same discharge through both while they were opposite the ends of the "fluorometer." The comparative values of different fluorescent screens could also be tested by slight modifications in the use of the instrument.

The practical bearing of this property of diffusibility of Roentgen rays is found in the consideration that, in making images or shadows of bone structures, or opaque objects when a considerable depth of fleshy layer exists between the objects and the sensitive plate, there must of necessity be a blurring or lessening of contrast, owing to diffusion of the rays into the space back of the opaque bodies. Indeed, by using the fluorescent screen tube, it is easy to note that the shadow of a piece of sheet lead is very black when near the screen, although there may be a block of wood, paraffine, or the like, between the lead and the Crookes tube. But the shadow obtained when the wood or paraffine is between the lead and the fluorescent screen is not black, but somewhat milky, thus showing diffusion.

The writer has not tried the experiment, but thinks that a cloud in the air, or mass of fine particles of condensed water from a steam jet, would diffuse the rays. The higher-pitch light waves are most readily diffused and absorbed by fog, and if Roentgen rays be considered as very high-pitch waves, similar to light waves, this diffusibility should not surprise us. The new rays seem to be detectors of molecular turbidity, so to speak.

Whether true gases have the power of diffusing the rays is not known, but the diffusive power, if it exists at all, is probably very small in such cases.

There was apparently a minimum of diffusive action given by an exhausted incandescent lamp bulb, and what action there was probably came from the glass and may have been reflective.

The metal plates tried gave apparently little diffusive effect, but appeared to reflect feebly at angles equal to the incidence angles. The fluorescence of reflection from surfaces has been worked upon by Mr. Tesla, and a number of figures given of the relative reflecting powers of metals, etc., tried.

The diffusive action herein noted is different altogether from reflection, and is obtained at all angles with the surfaces of the material upon which the rays fall.

* Opalescence in this article is used to mean milkiness or cloudiness, not a play of colors.

New Press for Notching Armature Disks.

The well known press and die manufacturers, the E. W. Bliss company, 17 Adams street, Brooklyn, N. Y., are calling attention to a press of entirely new design for notching armature core disks, for which they claim superiority in several important respects over other machines for the same purpose. The machine is well illustrated by the accompanying half-tone engravings.

The adjustment for different diameters is made by simply turning the hand-wheel shown. No alteration or readjustment of pawls or indexing parts to suit different diameters is required.

The adjustment for different numbers of notches is effected by means of change-gears instead of the usual pawl and index-plate device. One gear only need be substituted to obtain any desired alteration in the number of notches. This obviates the necessity of using a special indexing plate for each style of disk, and affects a considerable saving, as the change-gears are comparatively inexpensive. If one notch is punched at each stroke, the number of teeth in the gear corresponds to the number of notches in the disk. If two or three notches are punched simultaneously, the number of teeth in the gear is made one-half or one-third, respectively, of the number of notches.

Two standard sizes are being introduced, designated by the makers as No. 16 A and No. 39 A. No. 16 A weighs about 1,500 pounds, and will take disks of from three inches to 30 inches in diameter. It is designed to be run at a high rate of speed—from 60 to 240 strokes per minute, according to the work being done. The larger machine, No. 39 A, weighs about 2,800 pounds. It will take disks of from five inches to 48 inches in diameter, and may be run at about 100 strokes per minute. For very large disks the No. 39 A machine is built with an extra large clamping and indexing frame, so constructed that it will take disks of from 10 inches to 60 inches.

A Department of Commerce and Manufactures.

A bill which provides for the establishment of a Department of Commerce and Manufactures was introduced in the United States Senate on March 9, by Senator Frye, and was referred to the Committee on Commerce, in whose hands it now rests. This measure is one of great importance to the manufacturing and commercial interests of this country, and there is need for vigorous and immediate support of the bill by those whose interests it directly affects. To secure any action by the committee, or to obtain even a hearing upon the bill, it must be demonstrated to the members of the committee that the business men of the country are in favor of such legislation.

The ELECTRICAL REVIEW believes this movement is worthy of careful consideration, and suggests that its readers send to the National Association of Manufacturers, 1748 North Fourth street, Philadelphia, for free circulars of information on this subject, which is of undoubted importance to the electrical field.

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There will be a lively gathering of the electrical fraternity in the metropolis next month. New York will extend a cordial welcome to these progressive visitors. May their stay be pleasant and profitable.

The contemplated combination of the General Electric Company's factories near Elizabeth, N. J., would be one of the wisest moves that that company could make. According to our news on the opposite page, it means that the company would be given a brand new manufacturing plant costing $1,000,000 and a cash bonus of $575,000. They would still hold their old plants at Schenectady, Lynn and Harrison as assets. It is to be hoped that every obstacle to the deal being completed may be removed. The company would make a considerable saving in its manufacturing cost besides securing other and equally important advantages.

Tesla's latest investigations of the many interesting scientific questions arising from the Roentgen ray discovery are published in this issue. No step in the various stages that he has so far presented to the readers of the ELECTRICAL REVIEW is more interesting or suggestive. The relation which he demonstrates to exist between the series obtained by arranging the metals according to their reflective power and Volta's contact series in air, proves that the rays emitted from the bulb are not an isolated phenomenon, but are emitted everywhere. Particularly suggestive is the observation that all conductors emit streams similar to those discovered by Roentgen, and that the sun and other sources of radiant energies must pour forth rays of the nature of the cathode. To those devoted chiefly to the practical applications of Roentgen's discovery, Tesla's latest observations with a fluorescent screen, showing that even the heart can be seen, will appear most promising, while his investigation of the important effect discovered by Prof. J. J. Thomson (who has contributed so much to the advancement along these lines) can not fail to be of the greatest interest to scientific men.

THE PATENT COMMITTEE COMPLETED.

Mr. E. B. Thomas, president of the Erie Railroad Company, has been selected as the fifth member of the committee to manage the patents of the General Electric-Westinghouse alliance. As Mr. Thomas is a very busy man, it was necessary to appoint an alternate to serve in case of his absence. The alternate has been selected in the person of Mr. Samuel Spencer, president of the Southern Railway Company.

Both Messrs. Thomas and Spencer are eminently able and fair-minded men, and were agreed upon unanimously by the General Electric and Westinghouse interests.

These appointments complete the committee. The four original members were named in the ELECTRICAL REVIEW for March 25, just a month ago. They are Messrs. C. A. Coffin and F. P. Fish, representing the General Electric Company, and George Westinghouse, Jr., and Paul D. Cravath, representing the Westinghouse Electric and Manufacturing Company. It is fair to presume that these gentlemen will administer the patent affairs of the two great corporations named in a just and impartial manner. It is understood that the committee has taken offices at 120 Broadway, New York city, at which address its business will be transacted.

TESLA'S LATEST ROENTGEN RAY INVESTIGATIONS.

Further investigations concerning the behavior of the various metals in regard to reflection of those radiations have given additional support to the opinion which I have before expressed; namely, that Volta's electric contact series in air is identical with that which is obtained when arranging the metals according to their powers of reflection, the most electro-positive metal being the best reflector. Confining myself to the metals easily experimented upon, this series is magnesium, lead, tin, iron, copper, silver, gold and platinum. The last-named metal should be found to be the poorest, and sodium one of the best, reflectors. This relation is rendered still more interesting and suggestive when we consider that this series is approximately the same which is obtained when arranging the metals according to their energies of combination with oxygen, as calculated from their chemical equivalents.

Should the above relation be confirmed by other physicists, we shall be justified to draw the following conclusions: *First*, the highly exhausted bulb emits material streams which, impinging on a metallic surface, are reflected; *second*, these streams are formed of matter in some primary or elementary condition; *third*, these material streams are probably the same agent which is the cause of the electro-motive tension between metals in close proximity or actual contact, and they may possibly, to some extent, determine the energy of combination of the metals with oxygen; *fourth*, every metal or conductor is more or less a source of such streams; *fifth*, these streams or radiations must be produced by some radiations which exist in the medium; and *sixth*, streams resembling the cathodic must be emitted by the sun and probably also by other sources of radiant energy, such as an arc light or Bunsen burner.

The first of these conclusions, assuming the above-cited fact to be correct, is evident and uncontrovertible. No theory of vibration of any kind would account for this singular relation between the powers of reflection and electric properties of the metals. Streams of projected matter coming in actual contact with the reflecting metal surface afford the only plausible explanation.

The second conclusion is likewise obvious, since no difference whatever is observed by employing various qualities of glass for the bulb, electrodes of different metals and any kind of residual gases. Evidently, whatever the matter constituting the streams may be, it must undergo a change in the process of expulsion, or, generally speaking, projection—since the views in this regard still differ—in such a way as to lose entirely the characteristics which it possessed when forming the electrode, or wall of the bulb, or the gaseous contents of the latter.

The existence of the above relation between the reflecting and contact series forces us likewise to the third conclusion, because a mere coinci-

dence of that kind is, to say the least, extremely improbable. Besides, the fact may be cited that there is always a difference of potential set up between two metal plates at some distance and in the path of the rays issuing from an exhausted bulb.

Now, since there exists an electric pressure or difference of potential between two metals in close proximity or contact, we must, when considering all the foregoing, come to the fourth conclusion, namely, that the metals emit similar streams, and I therefore anticipate that, if a sensitive film be placed between two plates, say, of magnesium and copper, a true Roentgen shadow picture would be obtained after a very long exposure in the dark. Or, in general, such picture could be secured whenever the plate is placed near a metallic or conducting body, leaving for the present the insulators out of consideration. Sodium, one of the first of the electric contact series, but not yet experimented upon, should give out more of such streams than even magnesium.

Obviously, such streams could not be forever emitted, unless there is a continuous supply of radiation from the medium in some other form; or possibly the streams which the bodies themselves emit are merely reflected streams coming from other sources. But since all investigation has strengthened the opinion advanced by Roentgen that for the production of these radiations some impact is required, the former of the two possibilities is the more probable one, and we must assume that the radiations existing in the medium and giving rise to those here considered partake something of the nature of cathodic streams.

But if such streams exist all around us in the ambient medium, the question arises, whence do they come? The only answer is: From the sun. I infer, therefore, that the sun and other sources of radiant energy must, in a less degree, emit radiations or streams of matter similar to those thrown off by an electrode in a highly exhausted inclosure. This seems to be, at this moment, still a point of controversy. According to my present convictions a Roentgen shadow picture should, with very long exposures, be obtained from all sources of radiant energy, provided the radiations are permitted first to impinge upon a metal or other body.

The preceding considerations tend to show that the lumps of matter composing a cathodic stream in the bulb are broken up into incomparably smaller particles by impact against the wall of the latter, and, owing to this, are enabled to pass into the air. All evidence which I have so far obtained points rather to this than to the throwing off of particles of the wall itself under the violent impact of the cathodic stream. According to my convictions, then, the difference between Lenard and Roentgen rays, if there be any, lies solely in this, that the particles composing the latter are incomparably smaller and possess a higher velocity. To these two qualifications I chiefly attribute the non-deflectibility by a magnet which I believe will be disproved in the end. Both kinds of rays, however, affect the sensitive plate and fluorescent screen, only the rays discovered by Roentgen are much more effective. We know now that these rays are produced under certain exceptional conditions in a bulb, the vacuum being extremely high, and that the range of greatest activity is rather small.

I have endeavored to find whether the reflected rays possess certain distinctive features, and I have taken pictures of various objects with this purpose in view, but no marked difference was noted in any case. I therefore conclude that the matter composing the Roentgen rays does not suffer further degradation by impact against bodies. One of the most important tasks for the experimenter remains still to determine what becomes of the energy of these rays. In a number of experiments with rays reflected from and transmitted through a conducting or insulating plate, I found that only a small part of the rays could be accounted for. For instance, through a zinc plate, one-sixteenth of an inch thick, under an incident angle of 45 degrees, about two and one-half per cent were reflected and about three per cent transmitted through the plate, hence over 94 per cent of the total radiation remain to be accounted for. All the tests which I have been able to make have confirmed Roentgen's statement that these rays are incapable of raising the temperature of a body. To trace this lost energy and account for it in a plausible way will be equivalent to making a new discovery.

Since it is now demonstrated that all bodies reflect more or less, the diffusion through the air is easily accounted for. Observing the tendency to scatter through the air, I have been led to increase the efficiency of reflectors by providing not one, but separated successive layers for reflection, by making the reflector of thin sheets of metal, mica or other substances. The efficiency of mica as a reflector I attribute chiefly to the fact that it is composed of many superimposed layers which reflect individually. These many successive reflections are, in my opinion, also the cause of the scattering through the air.

In my communication to you of April 1, I have for the first time stated that these rays are composed of matter in a "primary" or elementary condition or state. I have chosen this mode of expression in order to avoid the use of the word "ether," which is usually understood in the sense of the Maxwellian interpretation, which would not be in accord with my present convictions in regard to the nature of the radiations.

An observation which might be of some interest is the following: A few years ago I described on one occasion a phenomenon observed in highly exhausted bulbs. It is a brush or stream issuing from a single electrode under certain conditions, which rotates very rapidly in consequence of the action of the earth's magnetism. Now I have recently observed this same phenomenon in several bulbs which were capable of impressing the sensitive film and fluorescent screen very strongly. As the brush is rapidly twirling around I have conjectured that perhaps also the Lenard and Roentgen streams are rotating under the action of the earth's magnetism, and I am endeavoring to obtain an evidence of such motion by studying the action of a bulb in various positions with respect to the magnetic axis of the earth.

In so far as the vibrational character of the rays is concerned, I still hold that the vibration is merely that which is conditioned by the apparatus employed. With the ordinary induction coil we have almost exclusively to deal with a very low vibration impressed by the commutating device or brake. With the disruptive coil we usually have a very strong superimposed vibration in addition to the fundamental one, and it is easy to trace sometimes as much as the fourth octave of the fundamental vibration. But I can not reconcile myself with the idea of vibrations approximating or even exceeding those of light, and think that all these effects could be as well produced with a steady electrical pressure as from a battery, with the exclusion of all vibration which may occur, even in such instance, as has been pointed out by De La Rive. In my experiments I have tried to ascertain whether a greater difference between the shadows of the bones and flesh could be obtained by employing currents of extremely high frequency, but I have been unable to discover any such effect which would be dependent on the frequency of the currents, although the latter were varied between as wide limits as was possible. But it is a rule that the more intense the action the sharper the shadows obtained, provided that the distance is not too small. It is furthermore of the greatest importance for the clearness of the shadows that the rays should be passed through some tubular reflector, which renders them sensibly parallel.

In order then to bring out as much detail as possible on a sensitive plate, we have to proceed in precisely the same way as if we had to deal with flying bullets hitting against a wall composed of parts of different density with the problem before us of producing as large as possible a difference in the trajectories of the bullets which pass through the various parts of the wall. Manifestly, this difference will be the greater the greater the velocity of the bullets; hence, in order to bring out detail, very strong radiations are required. Proceeding on this theory I have employed exceptionally thick films and developed very slowly, and in this way clearer pictures have been obtained. The importance of slow development has been first pointed out by Professor Wright, of Yale. Of course, if Professor Henry's suggestion of the use of a fluorescent body in contact with the sensitive film is made use of, the process is reduced to an ordinary quick photographic procedure, and the above consideration does not apply.

It being desirable to produce as powerful a radiation as possible, I have continued to devote my attention to this problem and have been quite successful. First of all, there existed limitations in the vacuum tube which did not permit the applying of as high a potential as I desired; namely, when a certain high degree of exhaustion was reached a spark would form behind the electrode, which would prevent straining the tube much higher. This inconvenience I have overcome entirely by making the wire leading to the electrode very long and passing it through a narrow channel, so that the heat from the electrode could not cause the formation of such sparks. Another limitation was imposed by streamers which would break out at the end of the tube when the potential was excessive. This latter inconvenience I have overcome either by the use of a cold blast of air along the tube, as I have mentioned before, or else by immersion of the tube in oil. The oil, as it is now well known, is a means of rendering impossible the formation of streamers by the exclusion of all air. The use of the oil in connection with the production of these radiations has been early advocated in this country by Professor Trowbridge. Originally I employed a wooden box made thoroughly tight with wax and filled with oil or other liquid, in which the tube was immersed. Observing certain specific actions, I modified and improved the apparatus, and in my later investigations I have employed an arrangement as shown in the annexed cut. A bulb B, of the kind described before, with a leading-in wire and neck much longer than here shown, was inserted into a large and

(Concluded on page 211.)

GENERAL ELECTRIC FACTORIES TO BE MOVED.

THE SCHENECTADY, LYNN AND HARRISON PLANTS TO BE CLOSED —THE FINEST ELECTRICAL MANUFACTURING PLANT IN THE WORLD TO BE ERECTED FOR THE COMPANY NEAR ELIZABETH, N. J. —A DEAL OF LARGE PROPORTIONS.

The ELECTRICAL REVIEW is credibly informed from several sources that the General Electric Company will close its large factories at Schenectady, N. Y.; Lynn, Mass., and Harrison, N. J., and will remove its entire manufacturing business to a new and modern plant to be erected for the company near Elizabeth, N. J.

The deal is one of great magnitude and has been hanging fire for over a year and a half. Nearly all the obstacles to its successful accomplishment have been disposed of, and it is expected that the final arrangements may be concluded this week.

The idea had its origin with a syndicate of Elmira, N. Y., and western capitalists, who have made several successes with improvement and industrial exterprises involving heavy land transactions. These gentlemen have formed the New Orange Industrial Association with handsome headquarters at 253 Broadway, New York city. Mr. C. W. Manahan is general manager of the company. Mr. Matthew Arnot, a very wealthy banker of Elmira, is heavily interested in the company, and is understood to be ready to supply any amount of money to carry out the proposed project. He is credited with being worth $15,000,000.

The New Orange Industrial Association has acquired a tract of land lying between Elizabeth and South Orange, N. J., aggregating five square miles in area. Five prominent railroads cross this tract of land. The scheme includes the building of a standard gauge electric belt line railroad connecting the five steam roads.

In order to make this tract of land valuable, it was necessary for the New Orange Industrial Association to attract manufacturers, and to that end the company is said to have made a most liberal offer to the General Electric Company. This offer is stated to include the following: The land company will build, to the value of $1,000,000, a manufacturing plant after the General Electric Company's own designs, the plant to be turned over in fee simple to the General Electric Company on its completion. The land company is to give the electric company a cash bonus of $400,000 and a further allowance of $175,000 for moving expenses. The old factories belonging to the General Electric Company remain their property, and in time may be sold or leased for a considerable sum.

The combination of the company's manufacturing interests in one place means that 10,000 or more hands will find employment in their factories, and a good-sized town will be required to accommodate the workmen and their families. It is judged that the General Electric Company, by this move, can reduce its manufacturing expenses at least 10 per cent and gain besides the advantages of shipping freight over five of the principal railroads.

THE NATIONAL ELECTRICAL EXPOSITION.

SOME OF THE PROPOSED EXHIBITS.

Great interest is being manifested by manufacturers and others in all parts of the country in the National Electrical Exposition, which is scheduled to open on May 4, in the Industrial Building, Lexington avenue and Forty-third street, New York city. Following will be found further particulars of some of the proposed exhibits:

The Mica Insulator Company, New York city, will exhibit their mica and micanite insulating specialties.

The Crocker-Wheeler Electric Company, New York city, will make a comprehensive exhibit in their special field of work.

Spon & Chamberlain, the well known publishers, of New York city, will display electrical and scientific books and publications. Both members of the firm will attend the Exposition.

The new type of armature disk notching press, manufactured by the E. W. Bliss company, Brooklyn, N. Y., will be exhibited in connection with the Crocker-Wheeler dynamo.

The Goubert Manufacturing Company, New York city, will display their steam specialties in a space they have taken, and will show others as a working exhibit in connection with other apparatus.

The Watertown Steam Engine Company, Watertown, N. Y., will exhibit a 10x12-inch, high-speed engine direct connected to an Eddy dynamo. Messrs. Robert E. Cahill and L. Copleston will be in charge of the exhibit.

The Columbia Rubber Works Company, New York, will show a line of hard rubber specialties, such as hard rubber sheet, rod and tubing, telephone receivers and push buttons. They will also exhibit a new fireproof compound.

The Fuel Economizer Company, Matteawan, N. Y., will exhibit sample castings of their economizer, photographs, blue-prints and various plans of boiler houses showing the various applications of their economizers in plants now working.

The Kennedy Valve Manufacturing Company, New York city, will display a line of extra heavy gate valves, especially designed to meet the requirements of modern power plants. They will also show a line of their standard gate and globe valves.

The Bradford Belting Company, Cincinnati, will exhibit their dynamo belting and Monarch insulating paint, of which they are the sole manufacturers. Messrs. E. F. Bradford, O. M. Hubbard and E. P. Morris will be present during the Exposition.

The Harrisburg Foundry and Machine Works, Harrisburg, Pa., will exhibit a 12x12-inch Ideal engine direct connected to a 40-kilowatt Eddy generator. W. R. Fleming & Company, of New York, will represent the Harrisburg people at the Exposition.

Chas. A. Schieren & Company, New York city, will exhibit their specialties in the electrical line, consisting of large three-ply and double main driving belts, and smaller sizes for use on street railway generators and electric light dynamos and all high-speed work.

The Riker Electric Motor Company, Brooklyn, N. Y., will exhibit several of their new fan motors, standard Riker machines and a direct-connected plant, consisting of a Riker dynamo and a Case engine. The latter is similar to those the company installs for yacht-lighting.

The Nowotny Electric Company, Cincinnati, will show their ironclad motors and dynamos and a number of entirely new electric light specialties of their own manufacture. President L. R. Keck, General Manager John S. Nowotny, and Mr. Wm. M. Venable will be present.

The Phœnix Iron Works Company, Meadville, Pa., will exhibit a Dick & Church tandem compound, non-condensing, automatic cut-off engine of 125 horse-power, direct connected to a 75-kilowatt Walker generator. Mr. C. A. White, of the company's New York office, will have general charge of the exhibit.

The Straight Line Engine Company, Syracuse, N. Y., will show a 13x15-inch, 125-horse-power engine direct connected to a 75-kilowatt General Electric dynamo and a 10x14-inch, 80-horse-power engine direct connected to a Crocker-Wheeler dynamo. The latter engine, it is understood, will be driven by compressed air.

The Ashcroft Manufacturing Company, New York city, will have a prominent exhibit of consolidated safety valves, Metropolitan injectors, Mocrop recorders, and Edson pressure recording gauge. The manufacturing privilege for the latter, this company have recently secured. This exhibit will probably be one of the most interesting in the line of steam specialties.

The Electrozone Company, New York city, intend to exhibit a working model manufacturing electrozone, a working model showing the Woolf process of bleaching wood pulp by electricity, and a working model showing the Woolf process of manufacturing caustic soda by electrolysis. The potency of the electrical disinfectant will be shown by killing infusoria and the lower forms of animal germ life.

Stanley & Patterson, of New York, will display a line of general electric light and electric bell supplies. As eastern agents they will represent the New York & Ohio company, manufacturers of Packard lamps; Brant & Thompson, manufacturers of porcelain goods; Indiana Rubber & Insulated Wire Company, manufacturers of Paranite wire, and the E. G. Bernard company, manufacturers of dynamos and motors. Messrs. Stanley, Patterson, Mead and Mays will be in attendance.

The E. T. Burrowes Company, Portland, Me., will exhibit models showing several styles of their automatic curtains for electric railway cars. They will also show a new waterproof curtain material called Oakette. Another part of their exhibit will be a cable device for holding curtains on an open car in place and a pinch handle device for an inside shade. While this exhibit will be small, the company will endeavor to make it interesting, as the curtain equipment of a car is by no means its least important feature.

The Standard Underground Cable Company, Pittsburgh, will exhibit a few reels of cable showing their standard fiber insulation and a specialty will be made of samples representing some of their most important recent contracts. There will also be a show rack for wires and cables and especially for small samples of lead-covered cable for distribution. Manager G. L. Wiley, of New York, and an assistant will attend the exhibition regularly, and Vice-president Marsh, of Pittsburgh, and Manager J. R. Wiley, of Chicago, will be present several days. The Standard company will distribute a novel electrical souvenir.

Hugo Reisinger, New York city, will make an extensive carbon exhibit, consisting of "Electra" high-grade Nuernberg carbons for arc lighting, for direct-current arc lamps on incandescent circuits, and for alternating current arc lamps; all descriptions of the finest grade of microphone carbons used in the manufacture of telephones; all descriptions of the very finest grades of battery carbons, and carbons used for search-lighting, for the manufacture of aluminum and for smelting all kinds of ores. Messrs. J. F. Outwater and Fred Nolker will represent Mr. Reisinger at the Exposition.

The exhibit of the Card Electric Motor and Dynamo Company, Cincinnati, will consist, in part, of the following apparatus: One 25-kilowatt generator directly connected to a Payne high-speed, automatic engine; a motor operating a Hoe press, the armature of the motor being directly connected to the shaft of the press in the place of the pulleys; a motor directly connected to a 37-inch Niles boring mill; a motor directly connected to a Niles six-foot radial drill and a three horse-power motor belted to a horizontal boring mill. They will also supplement their exhibit with some other special features which have as yet not been definitely decided upon.

In view of the importance of the occasion, the exhibit of the United States Patent office at the National Electrical Exposition will be made one of unusual size and interest. As now arranged by the department, under the instructions of Mr. S. T. Fisher, the acting commissioner, it will include no fewer than 361 separate models of electrical devices, apparatus, machinery and appliances, many of them embodying the fundamental and elementary ideas upon which the modern electrical arts have been founded. These models will occupy over 300 linear feet, and will be carefully grouped and classified, so that students of whatever character can follow the general lines of growth or evolution.

The Partrick & Carter Company, Philadelphia, will exhibit a general line of house goods, consisting of hotel and house annunciators, burglar alarms, hotel fire-alarm systems and return calls, and also a full assortment of bells, pushes and numerous other household electrical appliances. They will have in operation a complete line of their own goods, and it is their intention, if possible, to have on hand, during the entire time of the exhibition, thoroughly competent attendants. They will call in from the road two or three of their most important salesmen, among them Mr. Thos. L. Townsend, who is known to the general trade from Maine to California, to be on hand to visit the firm's many friends who visit the Exposition. It is also the intention of the members of the firm to be at the Exposition as much as they can conveniently.

The General Electric Company will occupy 400 feet of space fitted up as a headquarters and general reception room. They will show, as a still exhibit, a number of their latest long burning arc lamps, a selection of inclined coil instruments and a few meters. They expect to have a representative collection of bromide prints illustrating the company's latest types of apparatus and photographs of representative installations. The Convention Committee of the company, consisting of S. D. Greene, chairman; Chas. T. Hughes, vice-chairman; Fred M. Kimball, secretary; A. D. Page, lamp works; T. Beran, of the New York Supply Department, and F. N. Beyer, of the Chicago Supply Department, will probably be present during the entire convention. Messrs. H. J. Budd, representing the Philadelphia office; A. F. Giles, representing the Atlanta office; W. J. Ferris, representing the Chicago office, and Messrs. Chas. B. Davis, A. R. Bush, C. S. Haley and A. W. Ives, representing the Boston office, together with representatives from the railway, power, and mining departments and the New York office, will attend.

Kauffel & Esser company, New

York city, will show a handsome collection of drawing instruments and supplies and surveying instruments, such as are used in electric railway construction.

The C. W. Hunt company, New York city, will show Hunt's noiseless and frictionless conveyor adapted to the service of boilers in power stations. Mr. Harry P. Barr will be in charge of the exhibit.

Huebel & Manger, Brooklyn, N. Y., will make a handsome display of their electrical and brass goods. Mr. W. W. McChesney, Jr., will be in charge, and the members of the firm will be present to welcome their friends.

The Birdsall Electric Manufacturing Company, of New York city, will show a novel line of combination electrical specialties, which will undoubtedly attract attention. A few of them were recently described in the ELECTRICAL REVIEW.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., will exhibit a two-phase S. K. C. generator, a two-phase alternating current motor, transformers and switchboard apparatus. Mr. T. E. Theberath, the company's New York representative, will have charge of the exhibit.

The Peru Electric Manufacturing Company, Peru, Ind., will make a complete display of all the different pieces of porcelain which they manufacture, together with an exhibition of their Laclede and Hercules batteries. Messrs. Bonslog, Schutt and Stevens will be in charge of the exhibit.

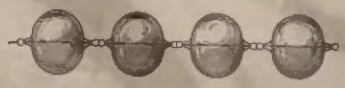
The Crane company, New York city, will show samples of their extra heavy I. B. gate valves for 200 pounds working pressure, extra heavy I. B. globe and angle valves for 200 pounds working pressure, standard and indicator valves, iron body blow-off valves, extra heavy flanged fittings for 200 pounds working pressure, and samples of many of their smaller specialties, such as brass valves, Pope safety valves, water relief valves and the like.

The Interior Conduit and Insulation Company, New York city, have secured a large space and will show in operation a printing press run by a direct-connected Lundell motor, exhaust fan outfits, 60 inches, 36 inches and 12 inches; direct-connected generating set, Lundell power motors, Lundell generators, Lundell desk-fan motors and ceiling-fan motors, Lundell dental outfits, Lundell emory wheel grinder, Lundell buffing machine and Lundell organ-blowing outfit. The latter outfit will be attached to a Mason & Hamlin organ, which will be played each evening. The company will also exhibit their complete system of plain, brass-armored and iron-armored insulating conduits as well as their complete underground conduit system. An illuminated sign 30 feet in length will be shown. The following-named gentlemen will be in attendance and explain the various novelties: Messrs. B. C. Durland, Geo. H. Kimber and E. B. Kittle.

In connection with the opening ceremonies of the National Electrical Exposition, when it is proposed to start the machinery by a circuit that has first looped in the whole continent, the Postal Telegraph Cable Company, through its vice-president, Mr. W. H. Baker, has very courteously offered its fine service between New York and San Francisco for the purpose. The Postal company has been equipping its lines with heavy copper circuits and believes that it can illustrate rapidity of working by the instantaneity of its transmission on May 4, when the mere pressure of the golden key will flash the signal to the golden gate and back to the Exposition building in the twinkling of an eye. Arrangements are now being made with the Postal officials for the execution of this interesting plan, with the co-operation of the long string of offices scattered over the 6,000 miles of wire.

J. C. Vetter & Company, New York city, will make an exhibit to demonstrate the application of the constant incandescent current in electro-therapeutics, by means of various instruments designed for the purpose. This apparatus consists of the following: Vetter current tap, by means of which the current from any lamp socket can be carried to a drop-light or fan motor without interfering with the lamp; current adapter, by means of which the lamp in the socket can be placed in series, and the current thus reduced and limited by the capacity of the lamp; carbon current controller; volt controller; standard milliammeter; cautery rheostat and various combinations of the above apparatus in the way of table bases, switchboards and cabinets. A feature of this exhibit will be a cabinet lately designed, which, in connection with the constant incandescent current, furnishes for electro therapeutical purposes the galvanic current, faradic current, sinusoidal current, cautery current, motor current and current for small diagnostic lamps. All these currents can be modified and manipulated to the finest degree. Mr. A. F. Vetter will attend the Exposition.

The Payne Engine Company, of 41 Dey street, New York city, and Elmira, N. Y., will have one of their new type direct-connected engines of 50-horse-power capacity connected to a 25-kilowatt card generator. This machine will undoubtedly be of unusual interest, from the fact that it will have an improved inertia governor of an exceedingly simple form of construction, and one for which is claimed very superior results. The governor consists of but two pieces and one bearing, thus reducing friction to the minimum and the chances of disarrangement. It is stated by manufacturers that this governor will move through the entire range, viz., from 0 to ¼ cut-off in less than one-fifth of a second, and it overcomes what is commonly known as "dancing" in the centrifugal governor. The Payne people will have another feature which will attract a good deal of attention. It is an automatic return oil circulation system, by means of which the oil is delivered in a stream to the main bearings by gravity, and drained to a central point at the bottom of the base. By means of a small oil pump working on the rocker arm of the valve rod, it is pumped to the receptacle on top of the frame, where it is filtered and reused. Carefully designed oil guards prevent any oil being thrown from the engine; and at the same time it is not the inclosed type. The Payne company will be represented at the Exposition by S. H. Payne, N. B. Payne and F. N. Jewett, of the New York office.



SOCKETLESS DECORATIVE INCANDESCENT LAMPS.

Realizing the impracticability of adequately exhibiting the working of its complicated and extensive plant in any reasonable space, the Metropolitan Telephone and Telegraph Company will make an exhibit illustrative of its New York city service as viewed from the user's standpoint. The manner in which this will be carried out involves, nevertheless, a more elaborate installation than might appear from the exhibit proper, as the company will place telephone stations at a number of exhibitors' spaces, as well as at points where service is desired by the Exposition company. These stations will be connected to a switchboard in the company's space, thus forming a small exchange within the exhibition itself. This service will be furnished without charge to the exhibitors and to the Exposition company by the Metropolitan Telephone Company, which will furnish the entire installation and maintain the service at its own expense. Besides the switchboard, the company will install in its own space four silence booths of different types, each equipped with telephone instruments of the various styles used by New York city subscribers. These will all be working stations connected with the Thirty-eighth street exchange and will be available to visitors to the exhibition in the same way as an ordinary public pay station. This remarkably useful form of exhibit will no doubt be highly appreciated by exhibitors who can not fail to realize the convenience of being placed in easy communication with each other and with their home offices. The exhibit proper will afford the public ample illustration of the excellent service furnished by the Metropolitan company and of the high grade of equipment provided for public and subscribers' stations. Those visitors who display particular interest in the operation of a city telephone system will be invited to visit one of the company's large exchanges, where they can examine in detail the nature and operation of the plant, which are practically impossible of reproduction in an ordinary exhibition.

PERSONAL.

Mr. C. M. Morse, of the Buffalo Engineering Company, Buffalo, N. Y., visited New York city last week.

Mr. Albert L. Johnson, of Cleveland, has been elected president of the Nassau Electric Railway Company, of Brooklyn, N. Y.

Among the out-of-town electrical men who visited New York city last week were Messrs. Estep, of Pittsburgh; C. J. Mayer, of Philadelphia, and Louis Myer, of Chicago.

Mr. P. H. W. Smith has been appointed assistant general manager of the Standard Underground Cable Company. Mr. Smith's training in electrical matters was received at Lehigh University, of which he is a graduate. He has been actively connected with the Standard Underground Cable Company for a number of years in the construction and sales departments, and the advancement is well merited and will be appreciated by his many friends. Mr. F. S. Viele has been made manager of the conduit and the general construction departments. Mr. Viele is a graduate of Massachusetts Institute of Technology in Electrical Engineering, and his ability in matters pertaining to insulated wires and cables makes him a valuable man for the company.

A Socketless Decorative Lamp.

The Empire Lamp Works, 154 and 156 West Twenty-seventh street, New York city, have just placed upon the market a series decorative incandescent lamp with which no socket is required. The accompanying illustration shows the lamps half size. They are made for three candle-power to run four in series on 50 to 60 volts, and eight in series on 110 to 120 volts. The lamps are especially suitable for decorative and display effects, and when hung in chains and festoons present a very beautiful appearance.

"I tell you what," said a fat, red-faced man as he stood in Park Row one evening last week; "I was just going to take that horse-car there, but I didn't, not on your tin-type, when I saw the sign in the window."

"What was it?" asked a friend.

"What was it?" repeated the fat man, scornfully. "What was it? It was 'This car is heated.' These horse car managers must be gibbering idiots."

THE HISTORY OF ELECTRIC HEATING APPLIED TO METALLURGY.

READ BEFORE THE WASHINGTON SECTION OF THE AMERICAN CHEMICAL SOCIETY BY FREDERIC P. DEWEY.

(Concluded from page 183.)

In 1887-88 a series of patents was granted to M. P. L. T. Heroult, in which alumina was melted by the passage of the current and then electrolyzed with molten copper, or iron, as the cathode with which the separated aluminum alloyed.

The furnace (Fig. 8) was a suitable containing vessel of carbon to which the negative wire was attached. The positive electrode was of carbon. In running the furnace, copper or iron was first put in and melted by the current, then alumina was added, which was also melted and then electrolyzed by the current. More alumina and copper, or iron, were added from time to time, and the resulting alloy was tapped out periodically.

This was a very promising high heat alloying process, but it, as well as the Cowles process, was superseded in the aluminum field by the Hall process of producing the pure metal, of which it is only necessary to say here that in this process the charge is both melted and electrolyzed by the current, but the fact is to be emphasized that only a comparatively low temperature is required.

From 1892 to March 15, 1895, there has been much published regarding the work of M. Henri Moissan, who has done so much fine work in the field of high temperatures, and has accomplished such wonderful results.

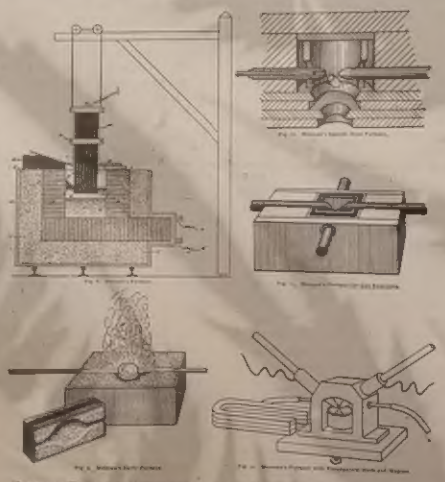
He employed various styles of furnaces and different amounts of current. His early furnace (Fig. 9) consisted of a simple block of quicklime suitably bound and provided with electrodes and a cover. In this, some very interesting results were obtained. Another furnace (Fig. 10) was especially designed for determining the temperature by the specific heat method. A piece of carbon was put on the end of one electrode, the current passed and the carbon pushed off from the electrode; at the same time a slide was withdrawn from the bottom of the furnace and the hot carbon allowed to fall in the calorimeter below. A number of temperature determinations were made in connection with M. Violle. Another furnace (Fig. 11) was provided with tubes for the introduction of gases. In this, pure and colorless carbide of silicon was formed from carbon and silicon vapors. This furnace also had various layers, beginning with lime on the outside, and followed by carbon and then magnesia on the inside, or vice versa. Another furnace (Fig. 12) had transparent ends of glass, or mica, so that the operations could be watched. It also had magnets to direct and control the arc.

In this, Moissan designed to investigate and study the simple heating effect of the current separated as much as possible from any electrolytic effect. He speaks of and treats the arc as one would speak of an ordinary flame.

Moissan began with a very moderate current of 35 to 40 amperes at 55 volts, and passed through various stages up to 1,200-1,600 amperes at 110 volts.

A few of the results obtained by Moissan may be mentioned. Magnesia was the only irreducible oxide found; it was melted and volatilized. Lime, strontia and magnesia began to volatilize before melting. Lime was easily melted and the metal calcium reduced, but it immediately combined with the carbon vapor, forming calcium carbide (CaC). Alumina and platinum were volatilized. Artificial diamonds were produced. Various temperatures from 2,000 degrees to about 3,800 degrees centigrade were measured. Carbon begins to volatilize at about 3,500 degrees centigrade. Various quantities of the rarer metals were reduced 200 to 300 grammes of uranium; 100 grammes of vanadium; 10 kilos of chromium, as well as manganese.

As in practical flame work, the amount of fuel burned determines the temperature of the furnace, so in this case the amount of current passed determines the temperature and the furnace must be designed to stand the current to be employed. While Moissan's small furnace will stand the temperature developed by small currents, yet with 1,200 amperes at 110 volts the lime and magnesia melt down, volatilize rapidly, and in a few moments the furnace is spoiled at a temperature of about 3,500 degrees centigrade.



ELECTRIC FURNACES MENTIONED IN "THE HISTORY OF ELECTRIC HEATING APPLIED TO METALLURGY."

For materials of construction it was found that lime was the best non-conductor for heat, but its fusibility and the ease of forming the carbide prevent its use for the inside of the furnace at very high temperatures. Compared with lime, carbon is a good conductor of heat. Magnesia is also a better heat conductor than lime. It does not form carbide of magnesium, and therefore can be heated very hot in direct contact with carbon, while lime can not. It, however, is volatile, and can be melted at very high temperature. Practically, therefore, the outside of the furnace is quicklime, while the interior is variously lined with carbon or magnesia, or both, and when carbon is in direct contact with the lime it must not get too hot at the point of contact.

In 1893 a United States patent, No. 492,767, was issued to E. G. Acheson, in which a mixture of silica, carbon and salt was heated by the passage of the current, and silicon carbide produced, which has found considerable application as an abrasive.

In the present early stage and activity of the calcium carbide and barium carbide questions, it might not be wise to go into the details of the work and the claims of the various workers (Borscher, Maquenne, Moissan, Travers, Willson—I arrange these names simply alphabetically), but I mention these various carbide processes to show the present condition of our subject, and to draw especial attention to a notable fact.

In reviewing our subject we find that in the early days the current was suggested, tried and used for various metallurgical operations, in which both the heating and decomposing actions of the current were utilized. Then in the principal, practical part of the field, that of the production of sodium and aluminum, the generation of intense temperatures became paramount. This activity culminated in the high heat processes of Cowles and Heroult, and they were very soon superseded by the low temperature process of Hall for the production of aluminum, which carried with it the greater part of the demand for the production of sodium.

At the present day, therefore, there is no practical production of metals by high electric heats, with the possible exception of the production of chromium. On the other hand, high electric heats are being employed to go a step beyond the reduction of the metals, and to form new compounds, as in the carbide processes mentioned. In these the metals are first reduced and are then immediately recombined with carbon, and thus in the field of high heat our subject becomes the application of high electric heat to chemistry.

Medico-Legal Society.

At the monthly dinner of the Medico-Legal Society, held at the Hotel Marlborough, New York city, on April 15, Dr. J. Mount Bleyer read a paper on "The Roentgen Rays in Medico-Legal Surgery."

TELEPHONE NEWS AND COMMENT.

There are said to be 150 opposition telephone companies in Ohio, Indiana, Illinois, Michigan and Wisconsin.

The directors of the Central Union Telephone Company have reduced the quarterly dividend from one and one-quarter per cent to one per cent.

The annual meeting of the New England Telephone and Telegraph Company will be held in New York May 4. Books closed April 2 and will open May 5.

The Central New York Telephone and Telegraph Company has issued its official list of subscribers No. 11. The list covers Syracuse, Utica and surrounding towns and is conveniently arranged.

A committee of the directors of the Erie Telegraph and Telephone Company have just returned from a thorough inspection of the telephone property in Minnesota, Arkansas and Texas, which they report in excellent condition.

The Elkhart, Ind., Telephone Company prints the following on its directory of subscribers: "Our rates are five cents per day for residences and seven cents for business houses. We have no war rates. Our office and exchange is over 229 South Main street. Come and see us."

The Erie Telegraph and Telephone Company has at present 28,000 miles of exchange lines, 19,000 subscribers and is increasing at the rate of 2,400 per annum. Already $400,000 has been invested in real estate, and it is the intention of the company to erect its own buildings in cities where there are 700 subscribers. These buildings cost about $15,000 each.

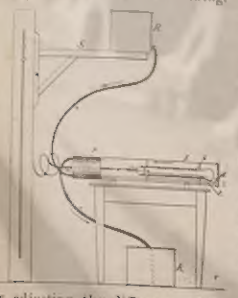
The Southern Massachusetts Telephone Company has commenced the work of putting its wires underground in Brockton, Mass., and expects to finish the job about July 1. The city wires will go underground with the telephone company's wires, but the electric light company will be compelled to find another way of providing for their wires, as it has been notified by the telephone company that it is intended to remove the poles in July.

A circular has been issued by the American Bell Telephone Company respecting the issue of 21,500 new shares of stock. Each stockholder of record March 31, 1896, is entitled to take and pay for shares of the new stock in the proportion of one share for every 10 shares then held. This right to subscribe will expire at 10 o'clock Saturday, May 16, 1896. Payment for full shares equal to one-half of the shares so subscribed for at the rate of $200 for each share must be made to the treasurer Wednesday, July 1, 1896, and for the remainder on Thursday, October 1, 1896.

TESLA'S LATEST ROENTGEN RAY INVESTIGATIONS.

(Concluded from last week.)

thick glass tube *t*. The tube was closed in front by a diaphragm *d* of parchment, and by a rubber plug P in the back. The plug was provided with two holes, into the lower one of which a glass tube t_1, reaching to very nearly the end of the bulb, was inserted. Oil of some kind was made to flow through rubber tubes *r r* from a large reservoir R, placed on an adjustable support S, to the lower reservoir R_1, the path of the oil being clearly observable from the drawing.



By adjusting the difference of the level between the two reservoirs it was easy to maintain a permanent condition of working. The outer glass tube *t* served in part as a reflector, while at the same time it permitted the observation of the bulb *b* during the action. The plug P, in which the conductor *c* was tightly sealed, was so arranged that it could be shifted in and out of the tube *t*, so as to vary the thickness of the oil traversed by the rays.

I have obtained some results with this apparatus which clearly show the advantage of such disposition. For instance, at a distance of 45 feet from the end of the bulb my assistants and myself could observe clearly the fingers of the hand through a screen of tungstate of calcium, the rays traversing about two and one-half inches of oil and the diaphragm *d*. It is practicable with such apparatus to make photographs of small objects at a distance of 40 feet, with only a few minutes exposure, by the help of Professor Henry's method. But, even without the use of a fluorescent powder, short exposures are practicable, so that I think the use of the above method is not essential for quick procedure. I rather believe that in the practical development of this principle, if it shall be necessary, Professor Salvioni's suggestion of a fluorescent emulsion, combined with a film, will have to be adopted. This is bound to give better results than an independent fluorescent screen, and will very much simplify the process. I may say, however, that, since my last communication, considerable improvement has been made in the screens. The manufacturers of Edison's tungstate of calcium are now furnishing screens which give fairly clean pictures. The powder is fine and it is more uniformly distributed. I consider, also, that the employment of a softer and thicker paper than before is of advantage. It is just to remark that the tungstate of calcium has also proved to be an excellent fluorescent in the bulb. I tested its qualities for such use immediately and find it so far unexcelled. Whether it will be so for a long time remains to be seen. News reaches us that several fluorescent bodies, better than the cyanides, have been discovered abroad.

Another improvement with a view of increasing the sharpness of the shadows has been proposed to me by Mr. E. R. Hewitt. He assumed that the absence of sharpness of the outlines in the shadows on the screen was due to the spread of the fluorescence from crystal to crystal. He proposed to avoid this by using a thin aluminum plate with many parallel grooves. Acting on this suggestion, I made some experiments with wire gauze, and, furthermore, with screens made of a mixture of a fluorescent with a non-fluorescent powder. I found that the general brightness of the screen was diminished, but that with a strong radiation the shadows appeared sharper. This idea might be found capable of useful application.

By the use of the above apparatus I have been enabled to examine much better than before the body by means of the fluorescent screen. Presently the vertebral column can be seen quite clearly, even in the lower part of the body. I have also clearly noted the outlines of the hip bones. Looking in the region of the heart I have been able to locate it unmistakably. The background appeared much brighter, and this difference in the intensity of the shadow and surrounding has surprised me. The ribs I could now see on a number of occasions quite distinctly, as well as the shoulder bones. Of course, there is no difficulty whatever in observing the bones of all limbs. I noted certain peculiar effects which I attribute to the oil. For instance, the rays passed through plates of metal over one-eighth of an inch thick, and in one instance I could see quite clearly the bones of my hand through sheets of copper, iron and brass of a thickness of nearly one-quarter of an inch. Through glass the rays seemed to pass with such freedom that, looking through the screen in a direction at right angles to the axis of the tube, the action was most intense, although the rays had to pass through a great thickness of glass and oil. A glass slab nearly one-half of an inch thick, held in front of the screen, hardly dimmed the fluorescence. When holding the screen in front of the tube at a distance of about three feet, the head of an assistant, thrust between the screen and the tube, cast but a feeble shadow. It appeared some times as if the bones and the flesh were equally transparent to the radiations passing through the oil. When very close to the bulb, the screen was illuminated through the body of an assistant so strongly that, when a hand was moved in front, I could clearly note the motion of the hand through the body. In one instance I could even distinguish the bones of the arm.

Having observed the extraordinary transparence of the bones in some instances, I at first, surmised that the rays might be vibrations of high pitch, and that the oil had in some way absorbed a part of them. This view, however, became untenable when I found that at a certain distance from the bulb I obtained a sharp shadow of the bones. This latter observation led me to apply usefully the screen in taking impressions on the plate. Namely, in such case it is of advantage to first determine by means of the screen the proper distance at which the object is to be placed before taking the impression. It will be found that often the image is much clearer at a greater distance. In order to avoid any error when observing with the screen, I have surrounded the box with thick metal plates, so as to prevent the fluorescence, in consequence of the radiations, reaching the screen from the sides. I believe that such an arrangement is absolutely necessary if one wishes to make correct observations.

During my study of the behavior of oils and other liquid insulators, which I am still continuing, it has occurred to me to investigate the important effect discovered by Prof. J. J. Thomson. He announced some time ago that all bodies traversed by Roentgen radiations become conductors of electricity. I applied a sensitive resonance test to the investigation of this phenomenon in a manner pointed out in my earlier writings on high frequency currents. A secondary, preferably not in very close inductive relation to the primary circuit, was connected to the latter and to the ground, and the vibration through the primary was so adjusted that true resonance took place. As the secondary had a considerable number of turns, very small bodies attached to the free terminal produced considerable variations of potential on the latter. Placing a tube in a box of wood filled with oil and attaching it to the terminal, I adjusted the vibration through the primary so that resonance took place without the bulb radiating Roentgen rays to an appreciable extent. I then changed the conditions so that the bulb became very active in the production of the rays. The oil should have now, according to Prof. J. J. Thomson's statement, become a conductor and a very marked change in the vibration should have occurred. This was found not to be the case, so that we must see in the phenomenon discovered by J. J. Thomson only a further evidence that we have to deal here with streams of matter which, traversing the bodies, carry away electrical charges. But the bodies do not become conductors in the common acceptance of the term. The method I have followed is so delicate that a mistake is almost an impossibility.

NIKOLA TESLA.

New York, April 20.

Law Battery Company Burned Out.

The new plant of the Law Battery Company, at Cranford, N. J., was burned out on April 18. The heavy machinery was not damaged and the other losses are fully covered by insurance. The company is prepared to fill orders as usual.

New Telephone and Telegraph Companies.

CHEROKEE, IOWA.—The Cherokee Telephone Company has been incorporated by James F. Weart, R. L. Robie, A. B. Ross, W. H. Lysaght and W. A. Sanford. Capital stock, $25,000.

CHELSEA, MICH. — The Chelsea Telephone Company has been incorporated by Lynn L. Gorton, Henry Gorton, A. W. Wilkinson and others. Capital stock, $10,000.

WARREN, VT.—A telephone line is to be put in between this place and Roxbury, and will eventually be connected with the Northfield exchange.

INDIANAPOLIS, IND.—The Crown Point Telephone Company has been incorporated. Capital stock, $10,000. George W. Fisher is interested.

MADISON, WIS. — It is reported here that the Postal Telegraph Company intends extending its line from Freeport to this place, and that an office will be opened here by June 1. Guy E. Paine, manager of the Postal company in Chicago, is in the city looking for a suitable office.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

RAILROAD ARRANGEMENTS.

TO THE EDITOR OF ELECTRICAL REVIEW:

Arrangements have been made whereby delegates on the line of the Chicago & Alton road can use that road to Chicago and connect with the electrical special at that point for a fare and one-third, on the certificate plan. This will enable the St. Louis delegates to leave that city at 11.30 P. M., reaching Chicago at 8.30 A. M. the following day, which will enable them to remain in the latter city until the time the electrical special leaves, namely, 5 P. M. Saturday, May 2.

Very truly yours,

C. O. BAKER, JR.,
Master of Transportation.

New York, April 17.

HOTEL ARRANGEMENTS.

TO THE EDITOR OF ELECTRICAL REVIEW:

I am pleased to inform you that the Murray Hill Hotel, Forty-first street and Park avenue, has been selected as the hotel headquarters for delegates to our nineteenth convention, May 5, 6 and 7.

It is stipulated, however, by the hotel management that none of the guests make use of any part of the hotel for exhibition purposes or display any signs or placards in the halls or corridors.

The Exposition to be held under the auspices of this association will open May 4 in the Industrial Building, two blocks from the hotel headquarters. Respectfully,

GEO. F. PORTER,
Secretary.

New York, April 17.

Carbide of Calcium—Acetylene Gas.

The *Progressive Age* of April 15 presents the report of a commission which that enterprising journal sent to Spray, N. C., to investigate acetylene. The gentlemen were Messrs. Houston and Kennelly, of Philadelphia, and Dr. Leonard P. Kinnicutt, chemist. After a very exhaustive test the decision of the commissioners is summed up in the following table and paragraph:

Materials per day and per ton of gross carbide	
Labor per day and per ton of gross carbide	$14.29
Water power, 1,200 h.p.	11.00
Petty stores, waste, etc., $150 per annum	3.37
Taxes at $500 per annum	.41
Interest on investment at five per cent, $61,000	.274
Depreciation and repairs, five per cent on electric plant and turbine	1.870
Six per cent on countershafting, building, rolls and crusher	3.273
Twenty per cent on furnaces	.648
	.091
	$32.767

Our estimate, therefore, of the cost of producing calcium carbide at Spray—by working the furnaces 365 days a year and 24 hours a day, yielding on the average one ton of 2,000 pounds gross carbide a day—is $32.767 per ton. Of this amount $14.39 is for material. The freight charges on lime and coke are heavy at Spray and add materially to the cost.

Walter K. Freeman Convicted.

Walter K. Freeman, an electrical engineer, formerly of New York city, was convicted on Friday last in the Court of General Sessions in this city of criminal assault in the second degree. The extreme penalty for this crime is 10 years imprisonment.

RICAL WEEKLY IN THE UNITED STATES.

ILLUSTRATED

ELECTRICAL REVIEW

A Journal of Scientific and Electrical Progress

NEW YORK WEDNESDAY MAY 6 1891

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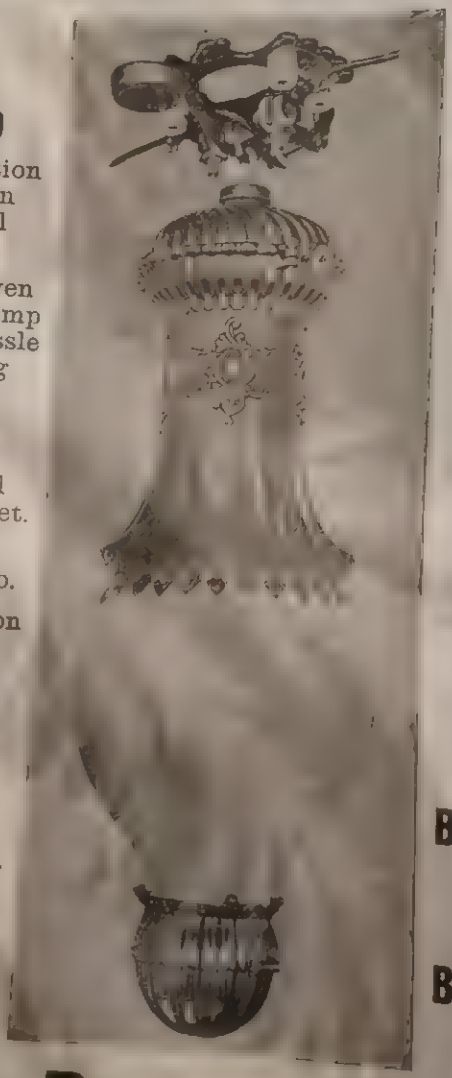
All the shadows must go.

The unsightly chimneys must go.

The carbon rod must go.

Wedging carbons must go.



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BE SURE

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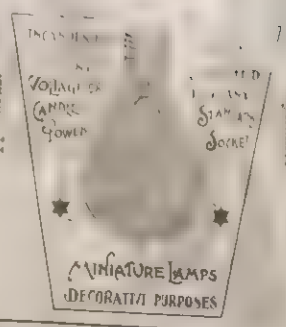

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VOL. 28. No. 21.
WEEKLY.

NEW YORK, WEDNESDAY MAY [illegible] 1896.

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VIEWS, NEWS AND INTERVIEWS.

Many of the readers of the ELECTRICAL REVIEW will remember the projector which Mr. L. H. Rogers installed on top of the Pulitzer Building, in New York city, to throw portraits and advertising signs on the clouds. In speaking of this apparatus the other day, Mr. Rogers stated that the apparatus was all right, but that it couldn't work without clouds. He waited 48 days in New York for a cloud to show up, and then when it came it was so thin the sign went right through it. Mr. Rogers received, a short time ago, an offer from the Russian state officials to install his projector [illegible] Moscow during [illegible] but the money [illegible] Moscow was too short [illegible] said Mr. Rogers, "I know three hours [illegible]

The dean of Harvard [illegible] editor of *Puck*, [illegible] Notes N. Y., May [illegible] from the literary [illegible] of the fewtally get [illegible] work Mr. Bunner [illegible] combination. [illegible] with a thousand [illegible] said [illegible] of readers.

Mr. H. L. Tapps, [illegible] the Thin Ann [illegible] Company, two [illegible] for nail holders [illegible] hooks, recently [illegible] to close trip to [illegible] guarantee [illegible] Dr. James, [illegible] pose a real [illegible] Mr. Staples [illegible] how to [illegible] He saw Co. R. [illegible] came with [illegible] applied with [illegible] the [illegible] Mr. Tapps [illegible] Mr. Tapps has [illegible] pretty [illegible]

I formed of Mr. Leonard the opinion that he was as sincere, honest, upright and straight as any man I ever knew. I formed the highest opinion of his integrity and probity."

For the Boers Mr. Shippey had little good to say.

"They are sneaky fellows, who would as soon stab you in the back as not," he declared. "I didn't like them at all. They make English speaking people as uncomfortable as they can all the time. They are overbearing, arrogant and not to be trusted. Traveling from Cape Town [illegible]

View [illegible] Stores [illegible]

[illegible] Mr. Tapps [illegible] Australia and New Zealand [illegible] Mr. Tapps [illegible] the *Sydney* [illegible]

[illegible] but [illegible] being con- [illegible] he has formed, or has arranged with others to form, the Austral [illegible] Electric Company, for the purpose of handling the whole of his inventions throughout Australia." When the above paragraph was shown to Mr. Edison he said it was news to him.

As already announced in the ELECTRICAL REVIEW an unfortunate accident happened last week to Prof. Elihu

The Jacques Carbon Generator

[illegible]

THE EVOLUTION OF THE ARC LAMP

[illegible]

The author of [illegible] could only conscient[illegible] upon such an [illegible] as this, before a body of men who are thoroughly familiar with arc lamps, who can instantly spot the first sign of a lack of [illegible] argument which must [illegible]

[illegible] ersed in [illegible] able for [illegible] time [illegible]

[illegible] he dynamos now used for arc and [illegible] ndescent lighting. The contem[illegible] ion is sufficient to cause us to love [illegible] Michael Faraday.

In place of the large number of [illegible]

[illegible] ome new device [illegible] ooked to its predec[illegible]

Improvements also began [illegible] made in the device which transformed the electric energy into light [illegible] light, although blinding to the eye, [illegible] ame weariness, simply as an ex[illegible] ment. It was found that the [illegible] al were gradually con[illegible] were burned, the [illegible]

[illegible] baked, and therefo[illegible] thus began the [illegible]

operate any number of lamps on one circuit, as the current momentarily required to operate the feeding mechanism in any given lamp would leave all the others undisturbed. This was a bold idea, and required inventive genius of a high order to carry it out.

[illegible]

of this unique arrangem[illegible] same as a controller [illegible] The more current pas[illegible] he fine wire the weaker [illegible]

[illegible] Faraday [illegible]

[illegible] the rapid [illegible]

[illegible]

ELECTRICAL REVIEW

Times Building 41 Park Row
[illegible] NEW YORK

EDITOR:
CHARLES W. PRICE
ASSOCIATE EDITOR
STEPHEN L. COLES

REGISTERED CABLE ADDRESS
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NEW ADVERTISEMENTS should be in the office not later than Saturday noon to insure publication the following week.

NEW YORK, MAY [illegible] 1896

[illegible]TENTS

[illegible]

INDEX OF ADVERTISERS

[illegible]

[illegible] of Tesla's [illegible] shown than that [illegible] present [illegible] inventor [illegible] the extraordinary [illegible] was [illegible] the scientific world [illegible] illustration of what he [illegible] vacuum tube which is capable of supplying [illegible] light [illegible] or more than a powerful [illegible] would not hesitate to express [illegible] positive [illegible] that the introduction of a more perfect illumination is near at hand.

The [illegible] of the *Morning Advertiser* has noticed the dimness of the Liberty [illegible] on Bedloe's Island [illegible] to blame electricity for it and suggests a test of electrical experts to see what is the matter [illegible] suggest a remedy. What is needed is a little more [illegible] on the part of the [illegible] United States Government [illegible] the grate a little more [illegible] a few more revolutions per minute [illegible] dynamo [illegible] name that [illegible] so little attention [illegible]

[illegible]

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TESLA'S IMPORTANT ADVANCES.

HIS REMARKABLE ACHIEVEMENTS IN VACUUM TUBE LIGHTING.

A representative of the ELECTRICAL REVIEW visited the laboratory of Mr. Tesla last week and found him engaged in putting the final touches to certain improvements in vacuum tube illumination. He was enthusiastic as to the results arrived at to such a degree that he expressed his positive confidence as to having made very important advances.

W[illegible] reluctant to speak at present [illegible]ly on the subject of his most recent investigations, he authorized the statement to the effect that he has been most successful in several lines of work he has been following up for a long time, only temporarily interrupted by the lamented destruction of his laboratory by fire about a year ago.

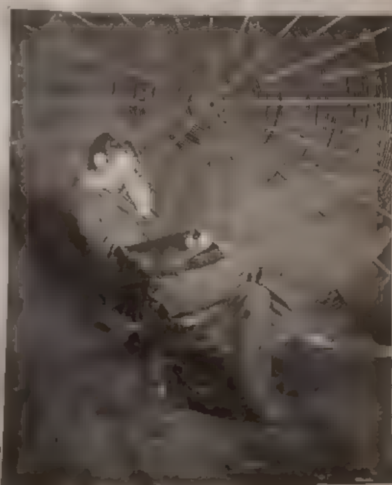
When asked about his often-men[illegible] oscillator he said that a [illegible] is now being com[illegible] which he expects to show [illegible] of this mode of [illegible] electricity.

[illegible] further stated with evident [illegible] great progress so much [illegible] now able to [illegible] Edison improv[illegible] screen recently purchased [illegible] Ashworth & [illegible]

[illegible]

faintly shown in the reproduction on this page. The photograph was made by Tonnele & Company, artists' photographers, who aided Mr. Tesla in [illegible] attempts to photograph by the light of phosphorescent tubes about two years ago.

When asked, Mr. Tesla said, in explanation of the picture, speaking with deep feeling that the volume he was reading was one of the "Scientific Papers," of Maxwell, given to him as a token of friendship by Professor Dewar, the [illegible] his warmest friend Mr. E. [illegible] Adams; and as to the queer co[illegible]



TESLA [illegible]

[illegible] the company's [illegible] but that [illegible] stated that [illegible] patent agreement with the Westinghouse Company will go into effect [illegible] patent [illegible] the matter may be [illegible] date.

[illegible]

General Electric Company's Annual Meeting.

The annual meeting of the General Electric Company was held at Schenectady, N. Y., on May 12. The representation of stock was 201,000 shares. George Foster Peabody was elected a director in place of Thomas K. Cummings, Jr. The balance of the old board of directors was re-elected. Only routine [illegible] was transacted and the question of capital impairment was not [illegible]

[illegible]

THE DESIRABILITY OF A STANDARD SOCKET

[illegible]

Street Journal recently, and stated that negotiations had been under way

TESLA IN HIS LABORATORY—PORTRAIT OBTAINED BY AN EXPOSURE OF TWO SECONDS TO THE LIGHT OF A SINGLE VACUUM TUBE WITHOUT ELECTRODES, HAVING A VOLUME OF ABOUT 90 CUBIC INCHES, GIVING APPROXIMATELY A LIGHT OF 250 CANDLE-POWER—PHOTOGRAPHED BY TONNELÉ & CO. COPYRIGHTED BY THE "ELECTRICAL REVIEW."

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ELECTRICAL REVIEW

THE COMMERCIAL VALUE OF ACETYLENE GAS AS AN ILLUMINANT

... Electric Light Convention Supplement

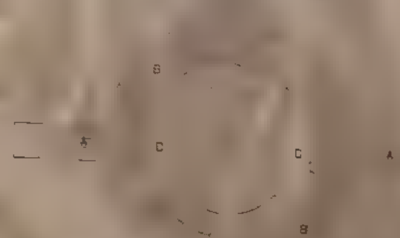
ELECTRICAL REVIEW

New York, May ...

SOME ACCOUNT OF THE EVOLUTION OF THE INDUCTOR ALTERNATOR

HOLMES 1888
A.A INDUCTOR POLES

HOLMES 1888
A.A INDUCTOR POLES
A.A EXCITING COIL

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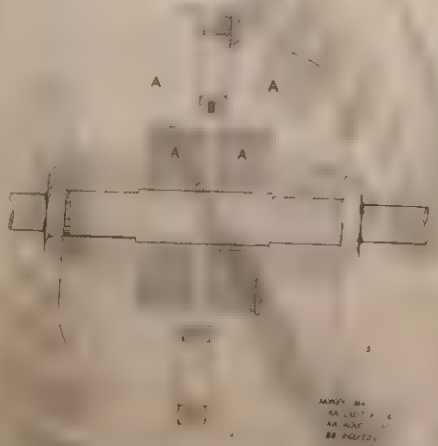
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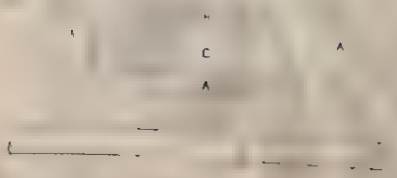
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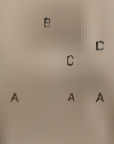
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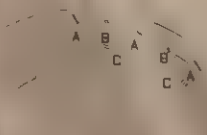
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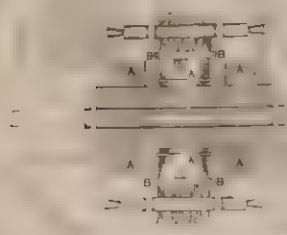
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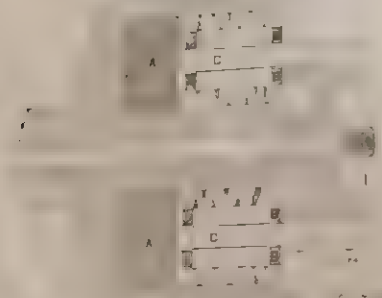
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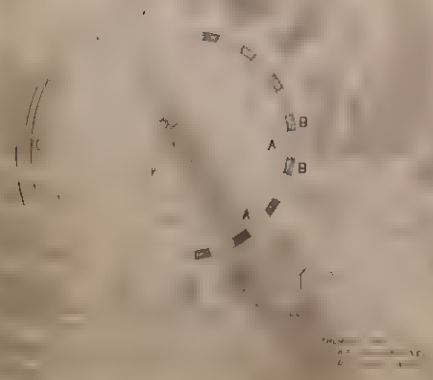
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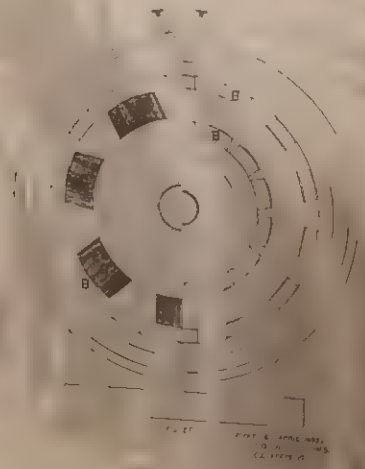
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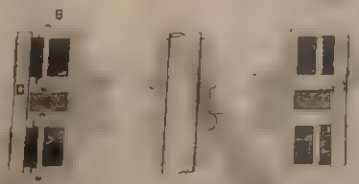

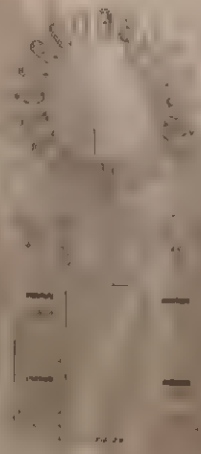

STEAM BOILERS: THEIR EQUIPMENT AND MANAGEMENT.

READ BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION MAY 7, 1896, BY ALBERT A. CARY.

[illegible] doubles do not [illegible] of the "penny [illegible] man, but there [illegible] of the plants [illegible]

[illegible] more money is [illegible] the igno[illegible] plants, [illegible] say from [illegible]

[illegible] comes to their steam plant, alas, how little they know, although they think [illegible]

[illegible] every [illegible] plants you often will [illegible] smoky chimneys painting the whole neighborhood [illegible]

the excessive amounts of coal used in these plants is considered a remarka[illegible]

[illegible] less water than the good, pound for pound, he knows that a delivery of inferior coal will be detected at once and it will cost him a customer [illegible]

There is probably no branch of trade employing abler men to discuss the merits of their output and sell [illegible] to pity the inexperienced purchaser who is not perfectly capable of form[illegible] consumption to [illegible] Such a man is very apt to [illegible] by the words of the [illegible] talker, or the one who tells [illegible] last, and in the end he is pretty sure to make a serious mistake by selecting a boiler very poorly adapted to the service it is intended for, or one for [illegible]

[illegible] one experienced in boiler practice, and let him decide for you. I do not mean by this that you want a man who knows simply one make of boiler [illegible]

[illegible] by [illegible] engine, we gen-[illegible]

erally find, has a cylinder of large diameter and a comparatively short [illegible]

[illegible] the boiler at a [illegible] times higher than that used at [illegible] engine and delivering the steam [illegible] reducing valve, [illegible] delivers the [illegible]

Graphite in Electrical Industries

Graphite, which is one of the [illegible]

[illegible] which is used for electrical smelting, and it is a graphite pencil or rod [illegible]

[illegible] is graphite pulverized to an impalpable powder that is used in electrolytic work by the copper smelters. [illegible] graphite is also used for lubricating cylinders and bearings of engines and dynamos, and the same material also forms the pigment for protective paints for trolley poles, electric light poles and roofs of dynamo plants and trolley car sheds. Graphite would therefore seem to be a very important factor in electrical industries. During the last year [illegible]

Niagara Falls Calcium Carbide Plant Started

[illegible] the light [illegible] Power Company was [illegible] at Niagara [illegible] April 27 [illegible] This [illegible] year [illegible] of the Niagara Falls Power Company and a [illegible] power is used.

[illegible]TERESTS

Mr. Frank H. Stewart, of Frank H. Stewart & Company, the supply house, of Philadelphia, has been in New York several days this week.

The Helios Electric Company, Philadelphia, has recently issued [illegible] the Helios standard arc lamp for direct and alternating currents.

The offices of the Valentine-Clark Company, of Chicago, dealers in poles for overhead wiring, have been moved from the Rookery to 804–5 Gaff Building, 230 La Salle street, Chicago, Ill.

J. A. Le Roy announces that he is prepared to manufacture an improved aluminum fluoroscope and also Roentgen-ray apparatus complete. Mr. Le Roy is located at [illegible] New York.

W. R. Ostrander & Company [illegible] speaking tube goods, have [illegible] No. 22 Dey street, New York [illegible] this company [illegible] the business and very [illegible] popularly known.

The Beacon Lamp Company, of Boston, Mass., the [illegible] known makers of [illegible] high grade X-ray tubes. Prospective purchasers of these tubes will find it to their [illegible] est to communicate with the [illegible]

The Grutting electric soldering iron and curling iron [illegible] rapidly becoming [illegible] standard goods. The [illegible] Appliance Company, of Chicago, [illegible] western agents are carrying a [illegible] these goods which are meeting with ready sale.

The Electric Appliance Company's complimentary duplicate order book advertising scheme has pro[illegible] left, which will be sent free [illegible] plication.

The new watch-case receiver of De Veau & Company, New York, [illegible] receiving [illegible] words of [illegible] from users. These [illegible] are satisfied [illegible] they have [illegible] The new [illegible]

The Goubert Manufacturing Company [illegible] 203 Monadnock [illegible] Chicago [illegible] These [illegible] of [illegible] Worcester, [illegible] Layton, [illegible]

THE GREATEST ELECTRICAL WEEKLY IN THE UNITED STATES.

ILLUSTRATED ELECTRICAL REVIEW

A Journal of Scientific and Electrical Progress

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THREE DOLLARS A YEAR

ILLUSTRATED

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VOL. 29. No. 7. WEEKLY

NEW YORK, WEDNESDAY, AUGUST

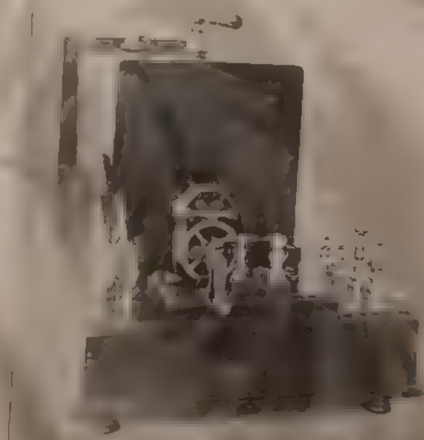
$3 PER ANNUM. Single Copies 10 Cents.

VIEWS, NEWS AND INTERVIEWS

[illegible]

Edwards's New Induction Coil

[illegible]



[illegible]

A New Illuminant

[illegible]

ELECTRICAL REVIEW

Times Building, 41 Park Row,
NEW YORK

EDITOR:
CHARLES W. PRICE

ASSOCIATE EDITOR:
STEPHEN L. COLES

REGISTERED CABLE ADDRESS
"ELECTVIEW," NEW YORK

1846 CORTLANDT, TELEPHONE CALL

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SPECIAL NOTICE TO ADVERTISERS

ADVERTISEMENTS for insertion in this paper must be in the office not later than Friday noon of the following week to insure publication.

NEW ADVERTISEMENTS should reach the office not later than Saturday noon to insure publication in the following week.

NEW YORK, AUG 12 1898

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Roentgen

ELECTRICAL REVIEW

A New Lightning Express Electric Railway System

LITERARY.

OBITUARY

NATIONAL [illegible]CTRIC LIGHT AS[illegible]

PRESIDENT[illegible]

[illegible] plished during [illegible] interval between conventions, [illegible] have earnestly endeavored [illegible] last annual meeting to [illegible] and, with the assistance of our [illegible]retary, to con[illegible] certain matters which I am hopeful will be approved of by [illegible] members [illegible]

[illegible] and Centra[illegible]

At our last conventi[illegible] on Relations between Ma[illegible] and Central Station Compan[illegible] was discharged, and the Executive [illegible]mittee authorized to take such action as might, from time to time, be found necessary in an endeavor to protect its active members from har[illegible] investments [illegible]

[illegible] manufacturing compan[illegible] an early period of my administration such a case arose, in a western town, [illegible] prompt and energet[illegible] the part of your [illegible] tion with the members of the [illegible]tive Committee, I placed [illegible] our association as to this [illegible] and as to unwise and [illegible]mpetition in general, [illegible] officers of the [illegible] companies [illegible] Light Company [illegible] Company, Fort Wayne [illegible] Westinghouse [illegible]

[illegible]

[illegible] United States, with the [illegible] scouting from [illegible] the hours of burning, [illegible] per lamp per night [illegible] this report you will receive [illegible] phlet form [illegible] such information from over 4[illegible]0 cities and towns, which list covers a very large ma[illegible]ority of the principal install[illegible]

[illegible] regularly for[illegible] copies of all [illegible] State that ma[illegible] large ma[illegible] acceded to our request, and several have already forwarded copies of all bills passed during the past session of their legislature, while others have promised to forward any that may be introduced during future sessions. These will all be filed in the secretary's [illegible] for the use [illegible] and [illegible] members of the [illegible]

[illegible] fare and add to the [illegible] association

Yours faithfully,

[illegible]

The Growth of the New York Telephone System

[illegible] than 2,300 telephone sta[illegible] nected to the New Yor[illegible] Tastes and requirements [illegible] telephoning differ as mu[illegible] anything else. One man [illegible] telephone all day long, another two or three times a day, while another practically does not call up at a[illegible] [illegible]

[illegible]RE RESISTANCE

[illegible] to work [illegible] We [illegible] extended [illegible] when [illegible] are

ON HYPERPHOSPHORESCENCE.

From the arc lamp, with an exposure of about two hours, shadows of pieces of metal were obtained on a photo- was found to be totally everything rad ated from the arc and to sunlight.

While the experiments on fogging were still in hand there was published the observation of M. Henry on the effect of sulphide of zinc in apparently augmenting the transparency of alum-

dell's "lightning" plate), and these were left for several days upon the

spots where portions of uranium nitrate and uranium ammonium fluo-

remarks ing with l ge

At an early stage of these investigations the use of a fluorescent screen revealed the fact that the relative

the rays ted from was unknown found to

the following methods

60 per sulphide of zinc, aluminum nesium and platinum. Of the metals in the above list, iron and platinum appeared to work better than copper or magnesium. The low aluminum and the last two render

these

emission of visible light by phosphorescent bodies does to the transparent

observed

Assignment of H. E. & C. Baxter.

MANUFACTURING NOTES.

POLICE AND [illegible] TELEGRAPH SUPERIN[illegible]

A NATIONAL [illegible] TO BE FORMED [illegible] SEPTEMBER 15 [illegible]

[illegible]LYN, [illegible] THE [illegible]

Away back in the dim mists of antiquity, or [illegible] at a more remote date than the retentive memory of the oldest inhabitant, some one suggested that in his judgment the superintendents of police and fire telegraph bureaus of the [illegible] and Canada should meet once [illegible] for consultation, enjoy [illegible] conduct themselves [illegible] officials do whose [illegible] them [illegible] rash [illegible] hed the subject was at first looked upon with suspicion by his fellow workers, was then tabooed and eventually passed into a nameless grave. It remained, however, for Mr. F. C. Mason, superintendent of the police telegraph system of [illegible], N. Y., to start the ball [illegible] [illegible] on the most [illegible] the world.

Letters were sent to the telegraph superintendents of the leading cities [illegible] suggest[illegible] have been received, all in favor of forming the association. The first meeting has been called for Brooklyn, N. Y., [illegible] those present [illegible] enjoyable time, including a sail [illegible] fish dinner at Pleasure [illegible] evening at Manhattan [illegible]

[illegible]

[illegible] Chief, [illegible] Police [illegible]

St. Paul, Minn., Thos. Carey, superintendent.

[illegible]

[illegible], Ky., Edward Hughes, chief, F. D.

[illegible]

Providence, R. I., [illegible]

[illegible]

Cleveland, Ohio, R. L. Palmer, Director of Fire.

Toledo, Ohio, C. F. Wall, chief.

Jersey City, N. J., W. H. [illegible], superintendent Police Telg.

[illegible], N. J., Jno. Spencer, superintendent Fire Telg.

Newark, N. J., Adam Bosch, superintendent, F. A.

Atlantic City, N. J., C. W. Brubaker, superintendent, F. and P. Tel.

[illegible]

Charleston, S. C., W. H. Easterlin, superintendent, Police Tel.

Syracuse, N. Y., Thos. Tyrrell, superintendent, Fire Alarm.

Syracuse, N. Y., [illegible], superintendent, Police [illegible]

Utica, N. Y., [illegible]

Columbus, Ohio, W. H. Murphy, superintendent City T[illegible]

[illegible], Pa., J. [illegible] Murphy, Department of Public Safety.

[illegible], N. Y., [illegible]

New York, N. Y., [illegible]

[illegible] F. P. Foster

[illegible] Drake, P[illegible]

Springfield, Mass., [illegible] Wheel[illegible]

[illegible]

Bridgeport, Ct., W. [illegible]

[illegible]

[illegible]

Baltimore, [illegible]

[illegible] of New York and [illegible] City will meet and arrange the plans for [illegible] the convention.

ELECTRIC RAILWAY NOTES

The Hardie air motor was last week [illegible] with apparent success on the tracks of the 125th street cable road in New York city.

The New York Stock Exchange has [illegible] Milwaukee Electric Railway and [illegible] Company.

The following statement of gross earnings of the Brooklyn Rapid Transit Company was issued last week:

	Gross earnings [illegible] 1896.	1895.	[illegible]
Brooklyn Heights R. R. Co.	$443,466.91	$447,7[illegible]	$[illegible]
Brooklyn, Queens Co. & Sub. R. R. Co.	[illegible]	[illegible]	[illegible]
Total	$49[illegible]	$[illegible]	[illegible]

The [illegible] of receipts over [illegible] is less than $3,000, a [illegible] showing than it was expected would be made.

The Mayor of Milwaukee has signed the franchise of the Milwaukee & Waukesha Electric Railway. [illegible] says: "We have been ready for some time, but shall now go ahead at once. We shall have [illegible] in operation within [illegible] months. The line is expected to cost about $[illegible],000. New York [illegible] the bonds are likely to be [illegible] in the East. There [illegible] Milwaukee Street Railway [illegible] North American Company has been interested."

KIND WORDS.

[illegible]

The Electric [illegible] Books [illegible] August [illegible]

ROENTGEN RAYS OR STREAMS

[illegible]

THE [illegible]

[illegible] the place of the first [illegible]

[illegible] SHADOWS IN SPACE [illegible] THE BULB

[illegible]

ILLUSTRATED
ELECTRICAL REVIEW
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ELECTRICAL REVIEW

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VOL. 29 No. 23
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VIEWS, NEWS AND INTERVIEWS

[illegible]

[illegible]

A Trolley Man-of-War

[illegible]

Electrical Review

Times Building, 41 Park Row,

[illegible] NEW YORK

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CHARLES W. PRICE.

ASSOCIATE EDITOR
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[illegible] only be supplied for one year [illegible]

Special Notice to Advertisers.

CHANGES for advertisements must be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office [illegible] to insure [illegible]

[illegible]

INDEX OF ADVERTISERS

TESLA'S LATEST CONTRIBUTION TO THE ROENTGEN RAY PHENOMENA

In this issue of the ELECTRICAL REVIEW we have the pleasure to bring to the attention of our readers another contribution on the subject of the Roentgen rays from the pen of Mr. Tesla, which, like all previous articles, [illegible] much useful and [illegible]

Mr. [illegible] he has already [illegible] and [illegible] new observations [illegible] of all workers [illegible] of investigation. We believe the [illegible] will prove of the greatest value.

[illegible] Mr. Tesla for the valuable [illegible] he gives for the application of Roentgen's discoveries to surgery.

His announcement of the real [illegible] by a number of experimenters will be [illegible] revelation.

Mr. Tesla touches on the recently brought out and sensational subject of "making the blind see" by means of the Roentgen rays, presenting arguments and regretfully showing the hopelessness of such a task.

This latest communication will particularly interest the readers of the ELECTRICAL REVIEW by the wealth of [illegible] suggestions and important information it [illegible]

[illegible] STOCKHOLDERS.

The following [illegible] from an interesting editorial in the [illegible]

It is an interesting and [illegible] movement [illegible] of the [illegible] central [illegible] company [illegible] employees [illegible] stockholders [illegible] the corporation. The stock is offered [illegible] at a stated price, at long easy terms, [illegible] being permitted to apply for [illegible] shares at a time, [illegible] on pay days in installments of $[illegible] or any multiple thereof. [illegible] purchase [illegible] for cash. Interest at the rate of five per cent. a year is allowed on payments until the installments equal the price of the stock, when [illegible] takes the place of the interest. In the event of [illegible] payments, the money is returned with interest.

[illegible] of the plan are [illegible] company [illegible] the employees [illegible]

[illegible] for electrical manufacturers [illegible] their goods. The [illegible] ELECTRICAL REVIEW [illegible]

[illegible] course, that [illegible] railroads. We [illegible] thing of the kind [illegible] in connection [illegible] We believe, however, [illegible] would suggest that [illegible] of the American [illegible] Association would be [illegible] discuss it.

[illegible] going to [illegible] electrocution in spite of many protests. The first test of the apparatus [illegible] set up in the State Penitentiary at Columbus, was made on [illegible] large bull dog being [illegible] was strapped in a [illegible] would be, and [illegible] and, naturally, the dog was killed. The machine will [illegible] in the presence of the [illegible] The experiments [illegible] these tests, which [illegible] that the electrical resistance of any human [illegible] between that of [illegible] and that of a mule. [illegible]

THE FINANCIAL SIDE.

[illegible] week of [illegible] in the business world. Bank clearings decreased some [illegible] per cent. [illegible] week [illegible] a year ago. The Associated Banks of New York [illegible] increase of [illegible] in loans. Since the election the increase [illegible] about [illegible] stands for that [illegible] improvement. Prices of stocks [illegible] the week [illegible] Metals [illegible] business interests [illegible] resulted [illegible] increase in business.

The [illegible] stock and [illegible] values [illegible] sight. [illegible] Electric [illegible] the market are [illegible] a deal [illegible] market will be [illegible]

There was [illegible] in any of the [illegible] electrical stocks listed on the New York Stock Exchange. [illegible] Boston Bell Telephone [illegible] points to 209 [illegible] In Philadelphia [illegible]

TESLA ON [illegible] [illegible]EN ST[illegible]

To the Editor [illegible]:

The follow[illegible] some useful inf[illegible] contain [illegible] and physicians. [illegible] exercise of their [illegible] applying the [illegible] to the relief of the suffering [illegible] determining the position of fore[illegible] objects [illegible] ascertaining the conditi[illegible] of local troubles or malformations in th[illegible] organism, are apt to be disappointed in many instances. While it is [illegible] fectly easy to find the position of a foreign object in the head, neck and all soft tissues of the body, and [illegible] some far gone trouble in the [illegible] often the location [illegible] and opaque object as a [illegible] imbedded in certain bo[illegible] trunk of the patient [illegible] with difficulties [illegible]

[illegible] the [illegible] number of observa[illegible] [illegible] of such cases, are strictly fol[illegible] [illegible]

[illegible] the present state [illegible] regard to the Roentgen rays [illegible] I entertain the view [illegible] expressed [illegible] that these rays are [illegible] matter projected [illegible] velocity and generally [illegible] from the walls of the [illegible] of the appa[illegible] ratus usually employed for the production of the rays; but [illegible]

[illegible]

A great diff[illegible] exact estimate [illegible] were, nevertheless [illegible] [illegible] the [illegible]

[illegible] sequences of the energetic impact

Of the various more or less plausible views in regard to the formation of these streams outside of the vessel, the simplest, to my mind, is to assume an actual projection through the walls of the [illegible] of the disintegrat[illegible] matter. Granted that there are particles sufficiently small within the bulb, then [illegible] up to many thousands of kilometers per second are [illegible] but a so[illegible] and even if the particles would not so further [illegible] impact against the walls [illegible] opaque [illegible] they [illegible] thicknesses of [illegible] [illegible] that all the disintegration [illegible] against the more or less impenetrable obstacle [illegible] [illegible] impact [illegible] the principal source of the rays [illegible] streams. Again [illegible] penetrative power of the streams [illegible] thick opaque [illegible] freely through [illegible] [illegible] Professor [illegible] was the first [illegible] [illegible] United States [illegible] It should be [illegible] that I do not [illegible] greater outward effect. It is [illegible] above fact which [illegible] more probable that [illegible] consists of particles [illegible] magnitude moving

with different velocities, for, were the former the case, the penetrative power would depend chiefly on the velocity. In the practical use of the Roentgen streams it would therefore, seem very important to find a method of filtering and rendering them homogeneous, for only by such a method can we hope to obtain exact results in their investigation. Streams of perfectly uniform velocity and character, if produced, would no doubt be more suitable for the purposes of research.

Since the disintegration of the electrodes, especially if they are of aluminum, is so slow that no appreciable diminution of the weight results even [illegible] that the matter [illegible] by the Roentgen streams [illegible] I have [illegible] showed that the bombarded [illegible] the glass was entirely permeated with particles of the [illegible] electrode, but it would probably require years of constant use to accumulate any appreciable amount of matter outside. Referring to a tube with an electrode of aluminum, it is a noteworthy fact that, if properly arranged, it does not impair in [illegible], but on the contrary, [illegible] to improve, whereas, [illegible] aluminum electrode is used, the life of the bulb is very short, owing to the conductor being deposited on the walls, which deposit, as I have explained on another occasion, renders [illegible] the passage of [illegible] charge. [illegible] as soon as [illegible] of the projected particles strike the [illegible] layer, they impart a similar electrification to the latter and a repulsion is exerted upon the particles following. The result is an a[illegible] increase in the resistance of the tube. The above [illegible] electrode, despite [illegible] must, in my opinion, lead to its abandonment.

It has been suggested that the Roentgen rays may be [illegible] propagation of electrostatic [illegible] but, on this assumption [illegible] to conceive how rays could [illegible] [illegible] instances when the glass wall is at a high temperature [illegible] [illegible] conducting, or when the [illegible] and connected to the ground. Stokes has recently considered the possibility that the impact of the cathode stream on one side of a partition might give rise to molecular motion on the other side without necessarily there being a [illegible] through the partition. According to this view, which I have likewise considered some time ago, it would appear that the material streams might start on the outer [illegible] of the wall of the tube, in which case only the [illegible] be responsible for the effects and the [illegible] of a spectral analysis test would be in a certain measure accounted for. But [illegible] not more probable to assume an actual passage and shattering of matter [illegible] thus directly? [illegible] as Professor Stokes [illegible] [illegible] and still capable of [illegible] of trans[illegible] extremely [illegible] frequ[illegible] question whether [illegible] Newton [illegible] should [illegible] rather [illegible] that the [illegible] observed by Roentgen are due to transverse vibration [illegible] whether [illegible] experimental ev[illegible] effect, nor even a satisfactory explanation [illegible] how the [illegible]

[illegible] greater [illegible] [illegible] temporary [illegible] transit [illegible] matter is [illegible] or else [illegible] rather [illegible] the former [illegible] peculiar [illegible] this [illegible] experiments [illegible] carrying [illegible] Roentgen rays [illegible] [illegible] energy [illegible] [illegible] present [illegible] an assertion [illegible] might be given [illegible] say that I expect [illegible] germ [illegible] the physiological effects [illegible] have [illegible] more recently [illegible] has that [illegible] been [illegible] just as [illegible] that one frequently experiences when stepping from a dark room into the glare of [illegible] walking for some time [illegible] free [illegible]

As to the [illegible] skin, which have been [illegible] reported [illegible] interpret [illegible] known [illegible] for some time [illegible] ing matters [illegible] They [illegible] rays [illegible] ated [illegible] trons [illegible] small [illegible] abundantly produced, attacks the skin [illegible] energet[illegible] [illegible] a crying [illegible] greater [illegible] have always taken [illegible] when getting [illegible] rays [illegible] the [illegible] ms of aluminum wire [illegible] connected to the ground [illegible] the [illegible] condenser. The [illegible] means, however, of [illegible] act [illegible] to make [illegible] exposing [illegible] [illegible] As this [illegible] [illegible] the [illegible] some [illegible] when that [illegible] gas [illegible] surface [illegible] so powerful that the [illegible] stances are practically [illegible] few minutes. When a [illegible] heavily [illegible] with [illegible] connected to the terminal of a high frequency coil [illegible] met [illegible] exposure [illegible] barely a minute [illegible] sufficient to completely wreck the [illegible] There are [illegible] compounds which [illegible] [illegible] distr[illegible] [illegible] the attack [illegible] and such

[illegible]

TESLA ON ROENTGEN STREAMS

[See ELECTRICAL

to humanity.

for a long time, as the

of the great advantage of the coil which consists in its being capable of giving a high potential through the secondary for a

here that ordinary air-gaps

to distances of many miles, with velocities not producible in any other way we know of. These missiles are so small that we may fire them through our tissues for days, weeks, months and years apparently without

resorted to for a quick heat treatment and immediately and very correct location of the projectile between shoulder blade and chest of the boy was ascertained and the bullet successfully extracted. NIKOLA TESLA.

TESLA ON ROENTGEN STREAMS

[illegible] luminous at [illegible] break out on all parts of the body, [illegible] abundantly on the feet, [illegible] nose and ears. I subjected myself a number of times to this [illegible] which seemed to offer no [illegible] except the possible rupture of a blood vessel, if the skin was very dry [illegible]. I then noted on [illegible]

[illegible] on the current for [illegible] and ozonize strongly [illegible] of a large [illegible] are also capable [illegible]

[illegible] have been following [illegible] time [illegible] phere on an [illegible] practically no [illegible] mechanical power. If more [illegible] tubes of this kind would be manufactured in this manner, the benefits to humanity derived therefrom would be incalculable. From the [illegible] action of the ozone, it follows that the experimenter should [illegible] indicated precaution, for, while [illegible] in small quantities is a most [illegible] disinfectant, when generated in large quantities it is not free of danger.

[illegible] an unpleasant duty to say [illegible] "making the [illegible] of the Roentgen [illegible] trated to be transverse vibrations. If they were so we would have to find means for refracting them [illegible] make [illegible] the projection [illegible] What [illegible] good can result from the application of these rays to [illegible] purposes? [illegible] impressions [illegible] known to be excited in two ways [illegible] mechanical shock and electrical transmission. Both of [illegible] I think are present in the Roentgen streams [illegible] effect on [illegible] might be expected. I may say, however, that I can not [illegible] of the experiments reported. For instance, when [illegible] the closed [illegible] it is easy [illegible] the same as before the light of a candle [illegible] the tube was inclosed and all light from the same [illegible] I fail to get [illegible] impression. The [illegible] therefore [illegible] these experimented with [illegible] it may be proper to recall

[illegible] ordinary [illegible]

[illegible] to a maximum, this [illegible] the highest velocity [illegible] rise to the most intense rays. But at that degree of exhaustion it may happen, and usually does happen, that the cathodic streams are not most abundant. To produce the best result it is necessary that both of these causes should be made to cooperate by a careful proportioning of the dimensions of the bulb, which in practice, is very difficult, inasmuch as the experimenter has to avail himself of commercial bulbs which may or may not be best suitable for his [illegible]. These [illegible] considerations [illegible] is capable of giving a [illegible] through the secondary [illegible] of what even the largest [illegible]

Assuming the [illegible] how to manipulate [illegible] best advantage, he will [illegible] depend [illegible] on the distance and degree of [illegible] investigation [illegible] without saying that [illegible] the better the [illegible] true only when [illegible] are taken at very [illegible]. When [illegible] distances [illegible] advantage to use [illegible] surface, as then [illegible] such a [illegible] too weak [illegible] this consideration, it is [illegible] intense the [illegible] of the body are [illegible] and much detail [illegible] impression might be altogether too weak to bring out sufficient detail.

To [illegible] in a popular manner the best way to [illegible] suppose that there [illegible] between two panes of [illegible] such as a [illegible] We may compare the [illegible] behind the [illegible] board, for instance, and the firing [illegible] shot through the [illegible] The shot will penetrate [illegible] points except [illegible] where the coin is located, and on the cardboard behind this place [illegible] by the absence of the marks. Exactly in this way we proceed in applying the Roentgen rays to the location of such a body. Roentgen rays [illegible] a gun to fire—a wonderful gun, [illegible] projecting [illegible] of a thousandfold greater penetrative power than that of a cannon ball, and carrying them probably

[illegible] know require a [illegible] to become luminous, and [illegible] way has been found as yet to produce a uniformity in velocity and magnitude of the [illegible] thought leads [illegible] conclusion that there will be a certain velocity of the missiles which will give, under all conditions, the best definition. This [illegible] will be best when [illegible] through [illegible] to make [illegible] that is the weaker an [illegible] to make the screen [illegible] the more detail will be revealed. It therefore follows that in the application of the Roentgen rays, [illegible] which fluoresces strongest [illegible] which is most sensitive [illegible] best suited for finer work.

[illegible] led me to adopt the following procedure which [illegible] has proved very successful. The Roentgen screen is first applied to the body to be investigated, the pressure at the terminals of the tube being very much reduced. The pressure is then slowly and gradually raised. It will be presently observed that at a certain pressure, the shadow of the object examined is clearest, but as the [illegible] is increasing, the pressure generally rises, and the image gets blurred in spite of the screen getting much brighter. Just as [illegible] the clearness is slightly diminished, the experimenter should for a few moments reverse the current [illegible] in this manner. The current being [illegible] given the direction it had at first, namely that which causes a [illegible] steady [illegible] of the [illegible] gets again clear [illegible] be easily manipulated [illegible] the best results may be secured. An additional advantage, however, is gained, because [illegible] a brighter phosphorescence of the screen. When taking a [illegible] the bulb should be watched through the screen and the switches manipulated in the above manner.

[illegible] a practical example of the effectiveness of this procedure I need only mention one of the instances which came to my notice. A few months ago I investigated the case of Mr. Cornelius Mack, of

[illegible] observe the mass [illegible] indicated [illegible]

Kindred.... ...Interests

The Kent Electric Manufacturing Company, Worcester, Mass., has issued a neat catalogue illustrating and describing its alternating-current motors, battery motors and light power specialties.

G. A. Frei & Company, 17 Bromfield street, Boston, Mass., have recently prepared a very satisfactory and complete catalogue of their X-ray supplies, which also contains a number of flattering testimonials as to the merit of their [illegible] catalogue is ready and for the asking.

The Electric Appliance Company, Chicago, report a splendid lamp business during the months of October and November. The Packard lamp not only holds its own, but gains ground every year in a way that indicates clearly that it is made of the right kind of stuff and has lasting merit.

McKenney & Waterbury, Boston.—Large contracts for gas and electric fixtures received [illegible] past week by McKenney & Waterbury include the City Hospital building, Massachusetts Benefit Association building, State street; Storage Warehouse building, Huntington avenue; Odd Fellows' building, Gardiner, Me.; Fitchburg Normal School, and the South Congregational Church, Concord, N. H. This firm is the largest in the business in New England.

The Phillips Insulated Wire Company, Pawtucket, R. I., are sending out a remarkably handsome and complete price list, as well as carefully prepared samples of their rubber and weatherproof wire, underground wire and Ideal wire, all of which they make in addition to their celebrated "O. B." weatherproof insulated wire. They are calling especial attention to their Ideal wire, which is a rubber insulation and white fireproof outside finish. This latter wire is made, to be used for exposed work where a good white finish is desired.

Probably no other among the many large [illegible] in the city of New York is the known or has [illegible] the Manufacturers Advertising Bureau. [illegible] was established [illegible] present [illegible] proprietor [illegible] Western, for many years publisher of the [illegible] and Manufacturer, [illegible] the Metropolitan Electrical Supply Co. of New York, etc., [illegible] agreement [illegible] the Bureau [illegible] and staging for the manufacturer and [illegible] component part, to remain with the [illegible] present [illegible] part of the United States, [illegible] bring to its work [illegible] experience and knowledge that [illegible] the best possible [illegible]

present location of the Manufacturers' Advertising Bureau—126 Liberty street—is an admirable one, and affords the best of facilities for transacting its business in a satisfactory and expeditious manner.

ADVANCE INFORMATION

Valuable News and Tips for Manufacturers and Dealers

We publish below information relating to new electric railways, new electric light companies, new telephone companies and projected electric construction of all kinds. Every reader will find these columns of special interest, and manufacturers and supply houses will receive many valuable suggestions looking to new business by carefully watching this department in the ELECTRICAL REVIEW.

Electric Light and Power.

BELLOWS FALLS, VT.—The Westminster Electric Company has been incorporated by George O. Guild, Benjamin B. Wetherbee, Charles K. Labarree and others, for the purpose of establishing an electric plant at Westminster, in Windham County. Capital stock, $50,000.

PHILADELPHIA, PA.—Joseph J. Dekinder can give information concerning proposed construction of a good municipal plant.

DES MOINES, IOWA.—Mayor MacVicar can give information concerning establishment of electric light plant to be built and owned by the city.

CLARKSVILLE, TENN.—R. M. Howard & Company are interested in proposed erection of electric light plant.

CAMERON, MO.—An electric light plant will be constructed at a cost of $12,000. They are in the market for the necessary machinery.

[illegible] may give information concerning the establishment of proposed electric light plant.

HARDWICK, VT. [illegible] light plant is rapidly approaching completion.

JACKSONVILLE, FLA.—A. P. Waller, of the Tarpon Springs Electric plant, will purchase material necessary for the completion of the electric light plant at St. Petersburg.

BARRE, VT.—Barre Electric Light and Power Company has been incorporated by Frank G. Howland, H. K. Bush, W. A. Parry, Geo. J. Reynolds. Capital stock, $150,000.

FORT WORTH, TEX.—Standard Light and Power Company has been incorporated by John C. Harrison, Wm. D. Harrison, George E. White, R. I. White. Capital stock, $100,000.

YOUNGSTOWN, OHIO.—A new electric light plant is to be established.

FAIRHAVEN, MASS.—It is reported that Mr. Joseph Nye, of this place, will erect an electric light plant.

RIVERSIDE, CAL.—The City Trustees are now considering the matter of municipal ownership of the city's electric system. The engineer has been called to [illegible] estimates of cost.

LOS ANGELES, CAL.—The West Side Electric Light Company has been incorporated. Directors are N. E. Peck, E. F. Billmeyer, of Los Angeles, George H. Baker, W. H. Sands and Walter S. Wright, of Pasadena.

BEAVER FALLS, PA.—The charter of the Valley Power and Light Company has been entered for record in the Recorder's office. The incorporators are Wm. A. McCoul, president, Hunter Eckert, secretary; H. M. Reese, treasurer; A. S. Reeves and [illegible] Bressner. The latter two are of Philadelphia. The company is capitalized at $3,000.

SOUTHBRIDGE, MASS.—Agitation of the subject of lighting the town by electricity is started, and the Southbridge electric plant has it under consideration.

SAN FRANCISCO, CAL.—There is more than a probability that a portion of this year's appropriation for Golden Gate Park will be used for the purpose of lighting the park with electricity.

OPHIR, COLO.—Final plans are about completed for a system of electric lighting for this place. The power will be furnished by the Dunn power plant at Ames.

MILLSTADT, MO.—An electric light plant, to cost $8,000, is to be erected here.

New Electric Railways.

POULTNEY, VT.—The Western Vermont Street Railway Company applied for articles of incorporation to operate a street railway in the towns of Middletown Springs, Poultney, etc. Incorporators are Leander Gray, A. Y. Grey, A. A. Greene, A. H. Varney, J. B. Beaman, E. H. Phelps and Jerome B. Bromley. Capital stock, $100,000.

[illegible], KAS.—The Pittsburgh, [illegible] & Columbus Railway Company [illegible] Surveyor A. N. Attmann [illegible] and Sam Bryant [illegible] a street railway [illegible] Crawford county. Capital stock, $200,000.

RACINE, WIS.—The Milwaukee Racine & Kenosha Electric Railway Company has been incorporated to operate an electric street railway system from South Milwaukee, northerly through Cudahy and the town of Lake and Oak Creek, then south through the towns of Caledonia and Yorkville, then south through the town of Caledonia and Mount Pleasant, city of Racine and the towns of Somers, Pleasant Prairie and city of Kenosha. Capital stock, $250,000.

NEW YORK, N. Y.—A permit has been granted to the Third Avenue Railroad Company to extend its tracks from 162d street along Kingsbridge Road and Broadway to Spuyten Duyvil Creek, and to use the trolley electric motive power.

MT. CLEMENS, MICH.—An ordinance has been introduced in the council granting a franchise to the Detroit, Lake Shore & Mt. Clemens railroad, to operate an electric railway in this city [illegible] the tracks of the Mt. Clemens Traction Company's track.

HAMILTON, OHIO.—A 50-year franchise has been granted to the Cincinnati & Miami Valley Traction Company to operate their lines through this county. Work must be begun by July, 1897.

PORTSMOUTH, OHIO.—An electric line from Scioto ville to New Boston will be built in the Spring.

New Telephone and Telegraph Companies.

JEFFERSON CITY, MO.—The Underground Telegraph and Telephone Company, the successor of the Sutter Subway Company, has been incorporated. Incorporators are Charles Sutter and Emil Meyenburg.

ELLICOTT CITY, MD.—A stock company is being organized in Howard County for the purpose of establishing an extensive telephone system in this county. The proposed line is to connect Guthers, Hood's Mill, Cooksville, [illegible] with [illegible] at Sykesville and [illegible] at Ellicott City. Incorporators are [illegible] Dorsey, M. A. Long [illegible], Elias [illegible] Dorsey.

[illegible] building a telephone line from the place to North Park is being agitated.

[illegible] the independent [illegible] ing constructed [illegible] this place and Warren will, upon its completion, be connected with the lines of the Youngstown Telephone Company, with the establishment of exchanges at Girard and Niles.

New Manufacturing Companies.

ST. LOUIS, MO.—The Electric Push Button Manufacturing Company has been incorporated; capital stock, $50,000. Incorporators: Anthony Silverston, W. Y. Hopkins and C. M. Nepton.

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Traction
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t. Airy,
Daisy,

$50,000. Incorporators: Anthony Silverston, W. Y. Hopkins and C. M. Napton.

GENUINE

lace and Oak Creek, then south through the towns of Caledonia and Oak Creek, then south through the towns of Caledonia and Mount Pleasant, city of Racine and the towns of Somers, Pleasant Prairie

Lisbon, Poplar Springs, Mt. Airy, Long Corner, Florence, Daisy,

38 Spring Park Avenue,
JAMAICA PLAIN, MASS.

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Company, Worcester, Mass., has issued a neat catalogue illustrating and describing its alternating-current motors, battery motors and light power specialties.

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McKenney & Waterbury, Boston

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NEW YORK, WEDNESDAY, JANUARY [illegible]

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VIEWS, NEWS AND INTERVIEWS.

[illegible] Andrew Carnegi[illegible] [illegible] Winter the handso[illegible] [illegible] the Interior Condu[illegible] [illegible] Company, at Greenwic[illegible]

[illegible]

The Appellate Divis[illegible] of the New York State Supreme [illegible] that a woman could n[illegible] ages from the Western [illegible] grief and anguish caused by [illegible] of a message which prove[illegible] attending her brother's funeral. In his opinion Justice Barrett [illegible] "There is, in fact, no con[illegible] [illegible]

[illegible]

Electricity in Paterson, N. J.

[illegible] tric Illuminating [illegible] of Paterson, N. J., belie[illegible] [illegible] tter knowledge of the [illegible] and simple laws govern[illegible] [illegible]

ELECTRIC LIGHTING IN TASMANIA

[illegible]

Messrs. [illegible]

[illegible]

[illegible] the gorge, wh[illegible] with those of the North Esk [illegible] the River Tamar. [illegible] for flour-mill [illegible] ration of electricity.

The City Surveyor, [illegible] after considering vari[illegible] [illegible]

VENTILATED ENCLOSED ARC

TELEPHONE NEWS AND COMMENT.

The First Radiograph Showing Arterial Circulation Made in Hudson Street Hospital New York

RADIOGRAPH SHOWING [illegible]

THE NORTHWESTERN ELECTRICAL ASSOCIATION

The Fifth Annual Convention Very Successfully Held in Milwaukee

[illegible]

The Crocker-Wheeler Installation in the New Astor Hotel

[illegible]

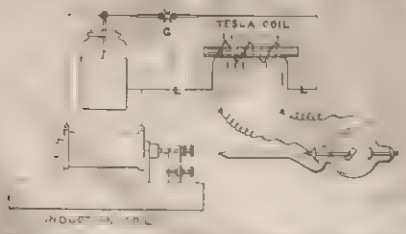
The Standard Edison Fluoroscopes and Fluorescence Screens

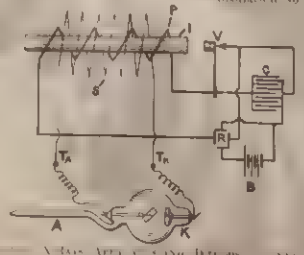
[illegible]

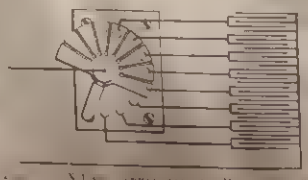
X Rays Detect Adulteration

[illegible]

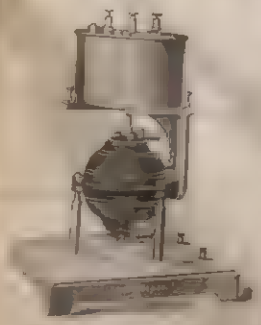
X RAYS APPARATUS AND METHODS

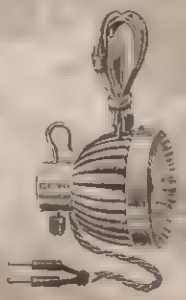






X RAY APPARATUS AND METHODS





Dr. Fleming's Lecture on the X Rays

The "Cat-eye" Electric Bicycle Lamp

TESLA ON ELECTRICITY

[illegible]

Editors Enjoy a Trolley Ride

The Republican Editorial Association of the State of New York held its annual meeting [illegible] last week. They devoted the afternoon of Thursday to a [illegible] ride over Brooklyn in the beautiful parlor trolley cars which President Rossiter of the Brooklyn [illegible] Railway Company provided for the occasion. [illegible] was served in the cars and it was a very enjoyable as well as novel experience for the visiting editors to be whirled through the city of Brooklyn and suburbs while enjoying an excellent repast. After the ride they visited the Brooklyn Navy Yard and were later entertained at a banquet at the Union League Club of Brooklyn, through the courtesy of the president of the association, Hon. William Berri, proprietor of the Brooklyn *Standard Union*. The after dinner speeches at the banquet were of unusual interest and were made by the following eminent gentlemen: Chauncey M. Depew, Rt. Rev. [illegible] Dunn, W. J. Arkell, George H. Daniels, Joseph Howard, Jr., Henry Watterson and Lieut. R. [illegible]ary, U. S. N.

Another Reason Why the Cable Should Go

From the New York Evening Sun

If you stand on a corner and wave your umbrella at a cable car, and it [illegible] past you without slowing [illegible] don't blame the gripman [illegible] the newspapers [illegible] were injured. It was [illegible] The [illegible] in front [illegible] have been doing its best.

A Belt Manufacturer Assigns

The assignment is reported of Edwin A. Burgess, a belt manufacturer in Providence, R. I., who did business under the name of A. Burgess & Son.

PERSONAL.

Mr. [illegible] Manufacturing Company [illegible] New York [illegible]

Mr. [illegible] Mr. [illegible] Company, of [illegible]

[illegible] Manufacturing Company [illegible] New York [illegible] Boston. His [illegible]

[illegible] West [illegible] Everett [illegible] State [illegible] Company [illegible]

Mr. F. T. [illegible] steam power [illegible] and contractor, is the eastern representative of the Ball Engine Company of Erie, Pa. Mr. [illegible] headquarters are at 3[illegible] Cortlandt street, New York.

Mr. F. Ward W[illegible], of the firm of Partrick & Carter Company, the well known [illegible] of [illegible] goods and general supplies, has started on a [illegible] at [illegible] between Chicago and San Francisco.

Mr. [illegible], formerly with the American Electrical Works, is now representing in New York city the [illegible] Works, of Boston [illegible] magnet, [illegible] rubber [illegible] weatherproof wires. Mr. [illegible] offices are at 13[illegible] Liberty street, New York city.

Mr. [illegible] H. Lease, son of Mrs. Mary Elizabeth Lease, the widely known [illegible] has [illegible] the Rousseau Electric Works, New York and will [illegible] to the electrical industry. The Rousseau company was [illegible] will no doubt be [illegible] Mr. Lease [illegible]

A Busy Factory.

The Adams-Bagnall factory at Cleveland is one of the busiest establishments in the country to-day, both in the arc lamp and incandescent lamp departments. [illegible] improved arc lamp of this company is meeting with much favor wherever tried and the increasing orders have filled every foot of factory space with workmen and moving machinery. The manager of this company, Mr. L. H. Rogers, is greatly pleased as he has every reason to be, over the success with which his company has been greeted. Mr. Thomas [illegible] Adams and Mr. E. [illegible] Bagnall are both actively interested with the company and the excellence of the product is largely due to the careful [illegible] of [illegible] persons.

TESLA ON ELECTRICITY.

[illegible]

human intellectual progress in more recent [illegible]

[illegible]

It was the artist, too, who awakened that broad philanthropic spirit which [illegible]

[illegible] here is no resistance. [illegible]

[illegible] frequency currents, which is now an ac-[illegible]

[illegible]

There [illegible] other [illegible] facture and industry in which the influence [illegible]

[illegible]

Editors Enjoy a Trolley Ride

The R[illegible] [illegible] Editorial Asso[illegible] tion of the State of New York [illegible] its annual meeting in [illegible] last week. They devoted the afternoon of Thursday to a trolley ride over Brooklyn [illegible] the beautiful parlor trolley cars which President Rossiter, of the Brooklyn Street Railway Company pr[illegible] for the [illegible]. Lunch was served [illegible] the cars and it was a very enjoyable as well as novel [illegible]

PERSONAL.

Mr. [illegible] of the [illegible] [illegible] and Manufacturing Company [illegible] New York [illegible] headquarters [illegible] the [illegible].

Miss Bessie [illegible] M. [illegible] Buck [illegible] of the [illegible] Wire [illegible] Company of Salem, Mass., were married in St. Peter's Church, Salem, on Jan. 11.

Col. [illegible] Burke, superintendent of the [illegible] Manufacturing Company of St. Louis, spent the past week in New York and Boston. His many friends in these cities gave him a cordial welcome.

The West End Street Railway Company, of Boston, has retained Everett W. Burnett to act as legislative [illegible] at the State House this Winter. He is also counsel for the Boston Electric Light Company at the State House.

Mr. [illegible] Copeland, the well known steam power engineer and contractor, is the eastern representative of the [illegible] Company of Erie, Pa. Mr. Copeland's headquarters are at 3[illegible] Cortlandt street, New York.

Mr. [illegible] Ward Wilkins, of the firm of Partrick & Carter Company, the well known [illegible] manufacturers of [illegible] general supplies, has [illegible] an extensive western trip [illegible] many of the principal [illegible] between Chicago and San Francisco.

Mr. [illegible] Scott, formerly with the American Electrical Works, is [illegible]

Editors Enjoy a Trolley Ride

Another Reason Why the Cable Should Go

From the

A Belt Manufacturer Assigns.

A Busy Factory

Electrical.... Patents.

A Puzzle in Photometry

American Institute of Electrical Engineers

Our New Direct-Current Tesla Coil

(INDORSED BY LEADING SCIENTISTS.)

Messrs. L. E. KNOTT APPARATUS COMPANY,
Gentlemen: Your high frequency for alternating circuit is giving very satisfactory results in the Roentgen experiments. Our Medical Association has expressed its highest appreciation of the working and results of the Coil. I am safe in saying that many experiments have verified your high claims of its efficiency. Yours truly,

URBANA, OHIO, Aug. 8, 1896.

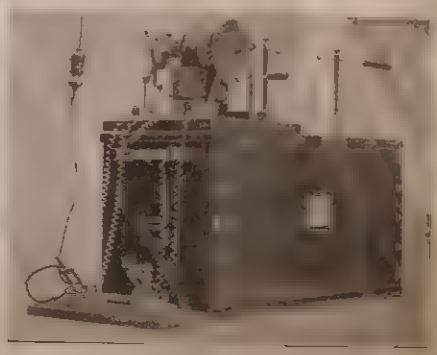
I. N. KEYSER,
Principal Urbana High School.

L. E. KNOTT APPARATUS CO., 14 Ashburton Place, Boston.

NEW X-RAY PAPER,
Superior to Plates.

HIGH-GRADE X-RAY APPARATUS,
Mechanically and Scientifically Perfect.

UNDISPUTED SUPREMACY.



L. E. KNOTT APPARATUS CO. INDUCTION COIL A DIRECT CURRENT FOR X-RAY WORK.

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ILLUSTRATED

ELECTRICAL REVIEW

A Journal of Scientific and Electrical Progress.

THE
BRUSH ELECTRIC
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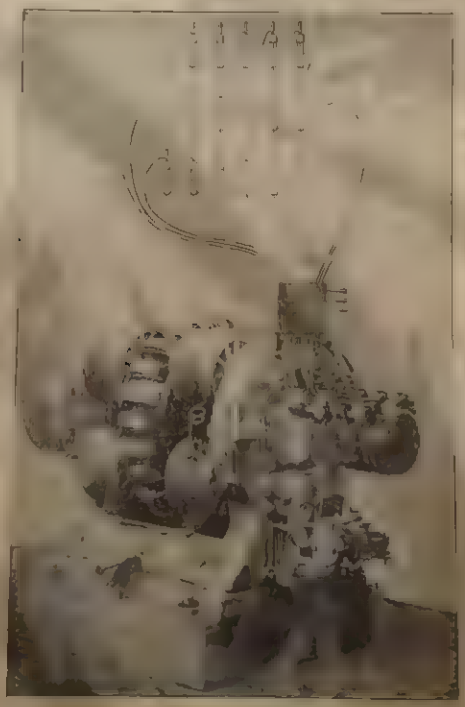
Brush ... the market ... years. A ... customers ... us. ... this ... and ... our ... Ask ... orders ... Office

FIRST BRUSH ARC DYNAMO 1877

... street ... Company ... arneg ... ding

... them ... Works ... Steel ...

... 40,000 ... large Brush ... dynamos ... A large ... Multi ... Dynamos ... designed ... have the ... 2000-candle ... lights ... lamps were ... of ... than ...



BRUSH MULTI-CIRCUIT 135-LIGHT ARC DYNAMO, 1897.

Two or more separate circuits run direct from one dynamo with any distribution of load on the different circuits.

The advantages are absolute flexibility in handling of circuits; reduction of high voltages on circuits run from large dynamos; use of large units with corresponding increase of efficiency; saving in floor space, oil, belts, shafting, pulleys, attendance.

ILLUSTRATED

ELECTRICAL REVIEW

A Journal of Scientific and Electrical Progress.

VOL. 31. No. 6. WEEKLY. NEW YORK, WEDNESDAY, AUGUST 11, 1897. $3 PER ANNUM / Single Copies, 10 Cents

Entered at Post Office New York as Mail Matter of the Second Class.

VIEWS, NEWS AND INTERVIEWS.

The telephone cable running from the Battery to Governor's Island parted the other day, probably because some craft ran afoul of it. Three men were sent out from the Battery in a rowboat to grapple for the broken ends. They were unable to raise them. Then one of the men, Leon Cholet, who is an expert diver, put on a bathing suit and tube was placed over the [illegible] region at a [illegible] for 10 minutes and resulted in no injury to the skin. In five of the patients only was the treatment persevered with. In two of these, where acute phthisis chanced to be aggravated by the results of alcoholism and poor living, there was no improvement whatever either in the general or the local conditions.

[illegible] could obtain its power from the water system of Colorado Springs. The power will be generated by the fall of water in coming down the pipes [illegible] the Beaver lakes the headwaters of the city system located on Pike's Peak, at an altitude of 12,000 feet. The city's water will be protected from contamination. Mr. Howebart is in Europe floating the bonds necessary for the construction

"LA LORGNETTE HUMAINE."

AN X-RAY DEVICE IN USE BY THE FRENCH CUSTOMS OFFICERS.

The Electrical Review some weeks ago [illegible] the fact that the French customs officers were experimenting with an X-ray apparatus designed to detect dutiable articles concealed about the clothing of a traveler or in sealed packages. The

[illegible] X-RAY APPARATUS.

FRENCH CUSTOMS EXAMINING X-RAY APPARATUS.

[illegible] finished underwater nearly 20 feet. He made a line fast to one of the broken ends and was hauled up. He came up for a breathing space, and then went down and got the other end. The ends were spliced and the repaired cable was lowered to the river bottom.

Many Canadian lumbermen who are now fighting the Brown-Corliss milling law, the American trans-continental telegraph wires are humming them up into billets.

M. Bergonié of Bordeaux, has recently made some researches into the action of the X-rays upon the progress of pulmonary affections. The patient was placed on boards [illegible] with [illegible] veiling, the cheeks

Three [illegible] cases of pulmonary tuberculosis showed [illegible] ration of general condition [illegible] alteration of the seat of suffering. [illegible] arrest of the disease. In three other cases the rays had no effect whatever. The [illegible] of X-rays seems [illegible] to have been [illegible]. [illegible] observations [illegible] was supported recently at the Biological Society by M. Beaujard, who reported the following: That the X-rays had a [illegible] action upon cultures of the bacillus of tuberculosis.

A press dispatch states that a franchise has been granted to the Hon. Irvin Hasselart and associates to construct an electric line between Colorado Springs, Col., and Cripple Creek, a distance of 30 miles. The franchise covers the new railroad which [illegible] cost $[illegible]. Work on grading has begun. The proposed [illegible] will have grades in places as high as 13 per cent.

The advertisement recently appeared in a Dundee Scotland paper: "Man wanted to attend Cows, and [illegible] the lights and make [illegible] Married man without a small family preferred. Apply at [illegible]."

A fine of $[illegible] was recently imposed by Justice Van Wart in the County Court, Civil Court, Westchester County, on Nassau Electric Railroad on account of Brooklyn, N. Y., for [illegible] tion of the fender ordinance. The [illegible] was begun several months ago by the city through the Corporation Counsel as a test case.

A magnifying glass shows this apparatus [illegible] and used by Prof. [illegible] Segundo while recently at the Pavilion de Foton and the rare in Nord. The apparatus consists of a square box of the dimensions of an ordinary stereoscope box, with a sloping front, upon which rests the [illegible] holder, and the case is a condensator, from which by a single turn of a knob the electric current passes through insulated wires into the tube thus producing the rays.

The "lorgnette humaine," or [illegible] for copying glass which [illegible] the heart, [illegible] one of the [illegible] and [illegible] perfect [illegible] the most important [illegible] of Prof. Segundo's [illegible] apparatus and [illegible] the

parted the other day, probably because some craft ran afoul of it. Three men were sent out from the Battery in a rowboat to grapple for the broken ends. They were unable to raise them. Then one of the men, Leon Cholet, who is an expert diver, put on a bathing suit and

and resulted in no injury to the skin. In five of the patients only was the treatment persevered with. In two of these, where acute phthisis chanced to be aggravated by the results of alcoholism and poor living, there was no improvement whatever either in the general or the local conditions.

French Customs Officer Inspecting a Woman's Hat and Hair by Means of X-Ray Apparatus.

vanished under water, nearly 25 feet. He made a line fast to one of the broken ends and it was hauled up. He came up for a breathing spell, and then went down and got the other end. The ends were spliced

Three chronic cases of pulmonary tuberculosis showed some amelioration of general condition, but no alteration at the seat of mischief and no arrest of the disease. In three other cases the rays had no appreci-

is coming down in pipes from the Beaver lakes, the headwaters of the city system, located on Pike's Peak, at an altitude of 12,000 feet. The city's water will be protected from contamination. Mr. Hewebart is in Europe floating the bonds necessary for the construction of the road, which will cost $1,500,000. Work on grading has begun. The proposed road will have grades in places as high as 13½ per cent.

This advertisement recently ap-

The ELECTRICAL REVIEW some weeks ago mentioned the fact that the French customs officers were experimenting with an X-ray apparatus designed to detect dutiable articles concealed about the clothing of a traveler or in sealed packages. The accompanying illustrations show this apparatus in an improved form devised by Prof. Gaston Séguy and which recently underwent successful tests at the Pavillon de Rohan and the Gare du Nord. The apparatus

FRENCH CUSTOMS OFFICER EXAMINING A HAND-SATCHEL BY MEANS OF X-RAY APPARATUS.

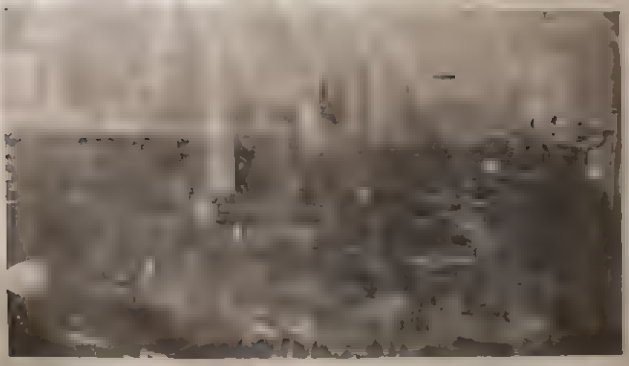
Electricity in Garvin's Machine Shop

The application of electric motors for power purposes is made by the Garvin Machine Company in the new building in New York city. The electric system has a total capacity of 800 horse power, and is supplied by the Crocker Wheeler type of 10 horse power motors and power generators. The motors are connected with the various machines by belting.

THE ECONOMY AND UTILITY OF ELECTRICAL COOKING APPARATUS

The Garvin Machine Company, New York.

[illegible]



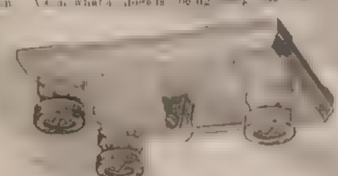
ELECTRIC LIGHT FLASHES.

TWO CASES OF ELECTRIC LIGHT BLINDNESS.

[illegible]

The McDonald Glass Hanger-Board

[illegible]



[illegible]

TELEPHONE AND COM[illegible]

[illegible]

Electrical Review

Times Building, 41 Park Row
NEW YORK

EDITOR:
CHARLES W. PRICE
ASSOCIATE EDITOR
STEPHEN L. COLES

Registered Cable Address
"ELECTVIEW NEW YORK

1586 "CORTLANDT" TELEPHONE CALL

WESTERN OFFICE
CARL E. KAMMEYER, Representative,
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CHANGES in advertisements must be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Saturday noon to insure publication the following week.

NEW YORK, AUG. 11, 1897

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TESLA ON THE [illegible] OF ROENTGEN RAYS [illegible] THE PRACTICAL CONSTRUCTION [illegible] ATION OF LENARD TUBES.

To the Editor [illegible]

I have for some [illegible] that a few indications [illegible] construction of [illegible] of improved designs, [illegible] which I have recently [illegible] before the New York Academy of Sciences (April [illegible]), would be useful and timely, particularly as by their proper construction and use much of the danger attending the experimentation with the rays may be avoided. The simple precautions which I have suggested in my [illegible] communications to your esteemed journal are seemingly disregarded, and cases of injury to patients are being almost daily reported, and in view of this only, were it for no other reason, the following lines, referring to this subject, would have been written before had not again pressing and unavoidable duties prevented me from doing so. A short and, I may say, most unwelcome interruption of the work which has been claiming my attention makes this now possible. However, as these opportunities are scarce, I will utilize the present to dwell in a few words on some other matters in connection with this subject, and particularly on a result of importance which I have [illegible] by the aid of [illegible], and which, if I am [illegible] only in part [illegible]

[illegible]

will be seen presently, it is not the only [illegible]

Since recording the above fact my efforts were directed to finding answers to the following questions: First, is it necessary that the impact body should be within the tube? Second, [illegible] that the obstacle in the path of the cathodic stream should be a solid or liquid? And, third, to what extent is the velocity of the stream necessary for the generation of and influence upon the character of the rays emitted?

In order to ascertain whether a body located outside of the tube and in the

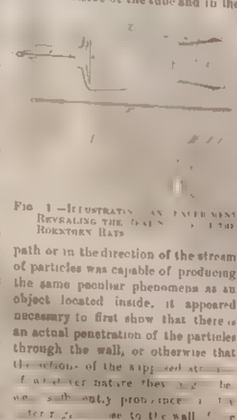
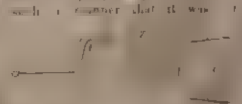


FIG. 1.—ILLUSTRATING AN EXPERIMENT REVEALING THE [illegible] ROENTGEN RAYS.

path or in the direction of the stream of particles was capable of producing the same peculiar phenomena as an object located inside, it appeared necessary to first show that there is an actual penetration of the particles through the wall, or otherwise that the [illegible] of the supposed stream [illegible]

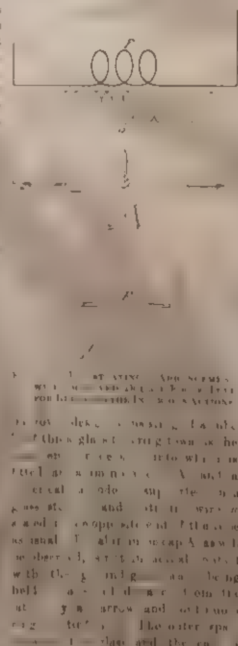
[illegible]



[illegible]

inside of the bulb, and, what is more, indications were obtained, by observing the shadows, that it behaved like a second source of the rays, inasmuch as the outlines of the shadows, instead of being sharp and clear as when the half-dollar piece was removed, were dimmed. It was immaterial for the chief object of the inquiry to decide by more exact methods whether the cathodic particles actually penetrated the window, or whether a new and separate stream was projected from the outer side of the window. In my mind there exists not the least doubt that the [illegible] I have [illegible] which I may dwell in the near future.

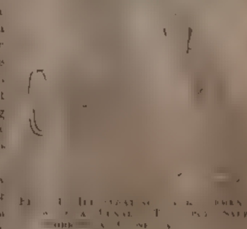
I next [illegible] whether it was necessary that the [illegible] a solid body or a liquid [illegible] in investigating [illegible] that I came upon the important result to which I referred in [illegible] served rather as [illegible] although I was following a systematic [illegible] what is illustrated in diagram Fig. 1. The diagram [illegible] Lenard tube of



[illegible]

e and the straight line W were, of course, at once recognized as the outlines of the cathode e and the bottom of the cap A respectively, although, in [illegible]

[illegible] exaggerated to a degree [illegible] darker line [illegible] glass [illegible] screen [illegible] affected the [illegible]



[illegible]

TESLA ON THE SOURCE OF ROENTGEN RAYS AND THE PRACTICAL CONSTRUCTION AND SAFE OPERATION OF LENARD TUBES.

To the Editor of Electrical Review:

I have for some time felt that a few indications in regard to the practical construction of Lenard tubes of improved designs, a great number of which I have recently exhibited before the New York Academy of Sciences (April 6, 1897), would be useful and timely, particularly as by their proper construction and use much of the danger attending the experimentation with the rays may be avoided. The simple precautions which I have suggested in my previous communications to your esteemed journal are seemingly disregarded, and cases of injury to patients are being almost daily reported, and in view of this only, were it for no other reason, the following lines, referring to this subject, would have been written before had not again pressing and unavoidable duties prevented me from doing so. A short and, I may say, most unwelcome interruption of the work which has been claiming my attention makes this now possible. However, as these opportunities are scarce, I will utilize the present to dwell in a few words on some other matters in connection with this subject, and particularly on a result of importance which I have reached some time ago by the aid of such a Lenard tube, and which, if I am correctly informed, I can only in part consider as my own, since it seems that practically it has been expressed in other words by Professor Roentgen in a recent communication to the Academy of Sciences of Berlin. The result alluded to, by reference to the

will be seen presently, it is not the only source.

Since recording the above fact my efforts were directed to finding answers to the following questions: First, is it necessary that the impact body should be within the tube? Second, is it required that the obstacle in the path of the cathodic stream should be a solid or liquid? And, third, to what extent is the velocity of the stream necessary for the generation of and influence upon the character of the rays emitted?

In order to ascertain whether a body located outside of the tube and in the

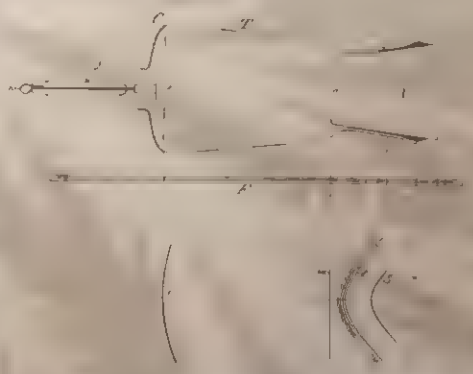


Fig. 1.—Illustrating an Experiment Revealing the Real Source of the Roentgen Rays.

path or in the direction of the stream of particles was capable of producing the same peculiar phenomena as an object located inside, it appeared necessary to first show that there is an actual penetration of the particles through the wall, or otherwise that the actions of the supposed streams, of whatever nature they might be, were sufficiently pronounced in the outer region close to the wall of the bulb as to produce some of the effects which are peculiar to a cathodic stream. It was not difficult to obtain with a properly prepared Lenard tube,

with this subject, and particularly on a result of importance which I have reached some time ago by the aid of such a Lenard tube, and which, if I am correctly informed, I can only in part consider as my own, since it seems that practically it has been expressed in other words by Professor Roentgen in a recent communication to the Academy of Sciences of Berlin. The result alluded to has reference to the much disputed question of the source of the Roentgen rays. As will be remembered, in the first announcement of his discovery, Roentgen was of the opinion that the rays which affected the sensitive layer emanated from the fluorescent spot on the glass wall of the bulb; other scientific men next made the cathode responsible; still others the anode, while some thought that the rays were emitted solely from fluorescent powders or surfaces, and speculations, mostly unfounded, increased to such an extent that, despairingly, one would exclaim with the poet:

"O gluecklich wer noch hoffen kann,
Aus diesem Meer des Irrtums aufzutauchen'"

My own experiments led me to recognize that, regardless of the location, the chief source of these rays was the place of the *first* impact of the projected stream of particles within the bulb. This was merely a broad statement, of which that of Professor Roentgen was a special case, as in his first experiments the fluorescent spot on the glass wall was, incidentally, the place of the first impact of the cathodic stream. Investigations carried on up to the present day have only confirmed the correctness of the above opinion, and the place of the first collision of the stream of particles—be it an anode or independent impact body, the glass wall or an aluminum window—is still found to be the principal source of the rays. But, as

necessary to first show that there is an actual penetration of the particles through the wall, or otherwise that the actions of the supposed stream, of whatever nature they might be, were sufficiently pronounced in the outer region close to the wall of the bulb as to produce some of the effects which are peculiar to a cathodic stream. It was not difficult to obtain with a properly prepared Lenard tube, having an exceedingly thin window, many and at first surprising evidences of this character. Some of these have already been pointed out, and it is thought sufficient to cite here one more which I have since observed. In the hollow aluminum cap A of a tube as shown in diagram Fig. 1, which will be described in detail, I placed a half-dollar silver piece, supporting it at a small distance from and parallel to the window or bottom of the cap by strips of mica in such a manner that it was not

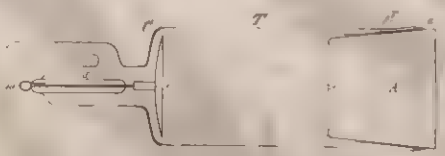


FIG. 2.—IMPROVED LENARD TUBE.

touching the metal of the tube, an air space being left all around it. Upon exciting the bulb for about 30 to 45 seconds by the secondary discharge of a powerful coil of a novel type now well known, it was found that the silver piece was rendered so hot as to actually scorch the hand; yet the aluminum window, which offered a very insignificant obstacle to the cathodic stream, was only moderately warmed. Thus it was shown that the silver alloy, owing to its density and thickness, took up most of the energy of the impact, being acted upon by the particles almost identically as if it had been

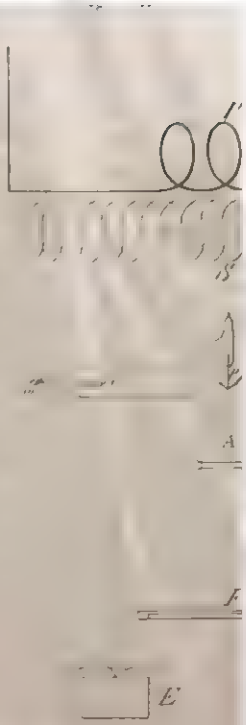


FIG. 3.—ILLUSTRATI
WITH IMPROVED D
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improved design, co
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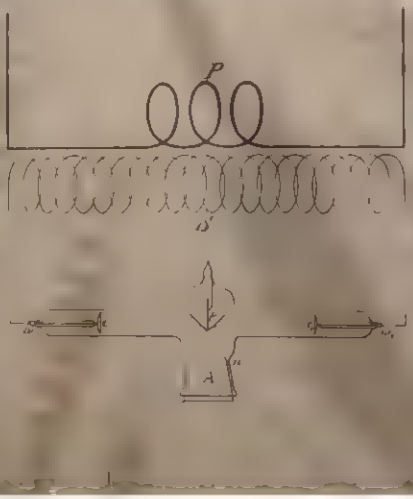
...e f... bulb, and, what is more, ... obtained, by observ... the shadows, that it behaved like ... source of the rays, inas... as the outlines of the shadows, ...stead of being sharp and clear as when the half-dollar piece was re...moved, were dimmed. It was immaterial for the chief object of the inquiry to decide by more exact methods whether the cathodic particles actually penetrated the window, or whether a new and separate stream was projected from the outer side of the window. In my mind there exists not the least doubt that the former was the case, as in this respect I have been able to obtain numerous additional proofs, upon which I may dwell in the near future.

I next endeavored to ascertain whether it was necessary that the obstacle outside was, as in this case, a solid body, or a liquid, or broadly, a body of measurable dimensions, and it was in investigating in this direction that I came upon the important result to which I referred in the introductory statements of this communication. I namely observed rather accidentally, although I was following up a systematic inquiry, what is illustrated in diagram Fig. 1. The diagram shows a Lenard tube of



e and the straight line W were, of course, at once recognized as the outlines of the cathode *e* and the bottom of the cap A respectively, although, in consequence of a confusing optical illusion, they appeared much closer together than they actually were. For instance, if the distance between *e* and *o* was five inches, these lines would appear on the screen about two inches apart, as nearly as I could judge by the eye. This illusion may be easily explained and is quite unimportant, except that it might be of some moment to physicians to keep this fact in mind when making examinations with the screen as, owing to the above effect, which is sometimes exaggerated to a degree hard to believe, a completely erroneous idea of the distance of the various parts of the object under examination might be gained, to the detriment of the surgical operation. But while the lines *e* and W were easily accounted for, the curved lines *f*, *g*, *a* were at first puzzling. Soon, however, it was ascertained that the faint line *a* was the shadow of the edge of the aluminum cap, the much darker line *g* that of the rim of the glass tube T, and *f* the shadow of the tinfoil ring *r*. These shadows on the screen F clearly showed that the agency which affected the fluorescent material was proceeding from the space outside of the bulb towards the aluminum cap, and chiefly from the region through which the primary disturbances or streams emitted from the tube through the window were passing, which observation could not be explained in a more plausible manner than by assuming that the air and dust particles outside, in the path of the projected streams, afforded an obstacle to their passage and gave rise to impacts and collisions spreading through the air in all directions, thus producing continuously new sources of the rays. It is this fact which, in his recent communication

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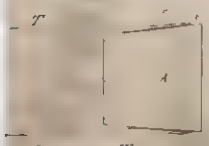

ED LENARD TUBE.

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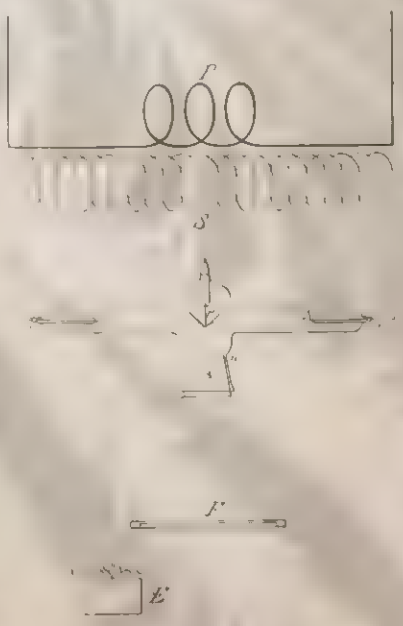


FIG. 3.—ILLUSTRATING ARRANGEMENT WITH IMPROVED DOUBLE FOCUS TUBE FOR REDUCING THE INJURIOUS ACTIONS

improved design, consisting of a tube T of thick glass tapering towards the open end, or neck *n*, into which is fitted an aluminum cap A, and a spherical cathode *c*, supported on a glass stem *s*, and platinum wire *w* sealed in the opposite end of the tube as usual. The aluminum cap A, as will be observed, is not in actual contact with the ground glass wall, being held at a small distance from the latter by a narrow and continuous ring of tinfoil *r*. The outer space between the glass and the cap A is filled with cement *c*, in a manner which I shall later describe. F is a Roentgen screen such as is ordinarily used in making the observations.

Now, in looking upon the screen in the direction from F to T, the dark lines indicated on the lower part of the diagram were seen on the illuminated background. The curved line

however, it was ascertained that the faint line *s* was the shadow of the edge of the aluminum cap, the much darker line *n* that of the rim of the glass tube T, and *r* the shadow of the tinfoil ring *r*. These shadows on the screen F clearly showed that the agency which affected the fluorescent material was proceeding from the space outside of the bulb towards the aluminum cap, and chiefly from the region through which the primary disturbances or streams emitted from the tube through the window were passing, which observation could not be explained in a more plausible manner than by assuming that the air and dust particles outside, in the path of the projected streams, afforded an obstacle to their passage and gave rise to impacts and collisions spreading through the air in all directions, thus producing continuously new sources of the rays. It is this fact which, in his recent communication before mentioned, Roentgen has brought out. So, at least, I have interpreted his reported statement that the rays emanate from the irradiated air. It now remains to be shown whether the air, from which carefully all foreign particles are removed, is capable of behaving as an impact body and source of the rays, in order to decide whether the generation of the latter is dependent on the presence in

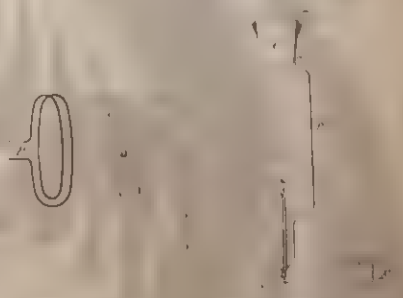


FIG. 4 ILLUSTRATING ARRANGEMENT WITH A LENARD TUBE FOR SAFE WORKING AT CLOSE RANGE

the air of impact particles of measurable dimensions. I have reasons to think so.

With the knowledge of this fact we are now able to form a more general

(Concluded on page)

TESLA ON THE SOURCE OF ROENTGEN RAYS AND THE PRACTICAL CONSTRUCTION AND SAFE OPERATION OF LENARD TUBES.

To the Editor of Electrical Review: [illegible]

I have for some time felt that a few indications in regard to the practical construction of Lenard tubes of improved design, a great number of which I have recently exhibited before the New York Academy of Sciences (April 6, 1897), would be useful and timely, particularly as by their proper construction and use much of the danger attending the experimentation with the rays may be avoided. The simple precautions which I have suggested in my previous communications to your esteemed journal are seemingly disregarded, and cases of injury to patients are being almost daily reported, and in view of this only, were it for no other reason, the following lines, referring to this subject, would have been written before had not again pressing and unavoidable duties prevented me from doing so. A short and, I may say, most unwelcome interruption of the work which has been claiming my attention makes this now possible. However, as these opportunities are scarce, I will utilize the present to dwell in a few words on some other matters in connection with this subject, and particularly on a result of importance which I have reached some time ago by the aid of such a Lenard tube, and which, if I am [illegible]

[illegible]

will be seen presently, it is not the only source.

Since recording the above fact my efforts were directed to finding answers to the following questions: First, is it necessary that the impact body should be within the tube? Second, is it required that the obstacle in the path of the cathodic stream should be a solid or liquid? And, third, to what extent is the velocity of the stream necessary for the generation of and influence upon the character of the rays emitted?

In order to ascertain whether a body located outside of the tube and in the

FIG. [illegible]—ILLUSTRATING AN EXPERIMENT REVEALING THE REAL SOURCE OF THE ROENTGEN RAYS.

path or in the direction of the stream of particles was capable of producing the same peculiar phenomena as an object located inside, it appears necessary to first show that there is an actual penetration of the particles through the wall, or otherwise that the actions of the supposed stream of whatever nature they might be were sufficiently pronounced at the outer region [illegible] wall of the bulb as to produce some of the effects which are peculiar to a cathodic stream. [illegible]

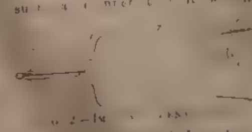


FIG. 2—[illegible]

[illegible]

inside of the bulb, and, what is more, indications were obtained, by observing the shadows, that it behaved like a second source of the rays, inasmuch as the outlines of the shadows, instead of being sharp and clear as when the half-dollar piece was removed, were dimmed. It was immaterial for the chief object of the inquiry to decide by more exact methods whether the cathodic particles actually penetrated the window, or whether a new and separate stream was projected from the outer side of the window. In my mind there exists not the least doubt that the former was the case, [illegible] I have been able to obtain numerous additional proofs upon which I may dwell in the near future.

I next endeavored to ascertain whether it was necessary that the obstacle outside was, as in this case, a solid body or a liquid, or broadly, a body of measurable dimensions, and it was in investigating in this direction that I came upon the important result to which I referred in the introductory statements of this communication. I namely observed rather accidentally, while I was following up a systematic inquiry, [illegible]

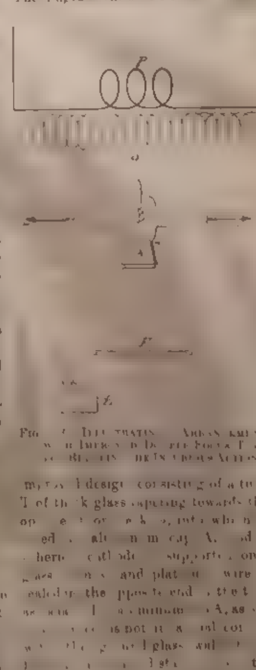


FIG. [illegible]—ILLUSTRATING [illegible]

[illegible]

[illegible] and the straight [illegible] were of course, at once recognized as the outlines of the cathode e and the bottom of the cap A respectively, although [illegible]

[illegible]

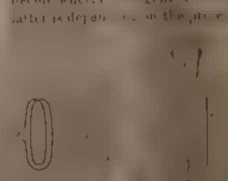


FIG. [illegible]

[illegible]

A NEW FORM OF INDUCTION COIL.

READ AT THE ... MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS ... 1894.

The induction coil presently to be described ... constitutes a new type employing the principle of ... primary ... which principle has been applied by me in a variety of ways. [illegible]

... with one terminal of battery ... charged ... stationary ... the break between ... on the main segment of ... [illegible]

Now let the break wheel ... be given rapid revolution ... or ... per second. The ... brushes ... and ... with the main segment ... passes current ... considerable fraction of the revolution ... [illegible]

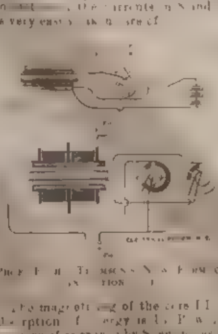


FIG. 1.—... A NEW FORM OF INDUCTION COIL.

... the magnetism of the core ... absorption of energy ... [illegible]

[illegible]

The Milwaukee ... Electric ... [illegible]

The Waukesha ... Railway Company ... stockholder has petitioned for the appointment of a receiver to wind up the affairs of the company, which was capitalized at $... The company was incorporated ... ago, but only enough of the road was built to protect the franchise. [illegible]

The Board of Public Works ... ordered ... of the Milwaukee Street Railway and Light Company for burying its feed wires ... [illegible]

The Postal Telegraph Company of Portland, Me., has brought suit ... the United States Circuit Court against ... [illegible]

... suit against the Cleveland, Ohio, Electric Railway Company ... [illegible]

A NEW FORM OF INDUCTION COIL.

READ AT THE FOURTEENTH GENERAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, ELIOT, ME., JULY 26–28, 1897, BY PROF. ELIHU THOMSON.

The induction coil presently to be described, it is believed, constitutes a new type employing the principle of a "substitute primary" or "secondary primary," which principle has been applied by me in a variety of ways.

The prime object of this coil is to permit the direct connection to circuits of considerable potential for obtaining energy for the production of high-potential discharges, like those of a Ruhmkorff coil for working Roentgen-ray vacuum tubes, and for such like purposes. The object, also, was to avoid the employment of banks of lamps or storage batteries, and to limit the energy consumed to only that amount required to work the coil itself. Furthermore, no larger condensers than those ordinarily used with an induction coil of equal capacity are needed, and no air-blast, while the coil as a whole is still available as an ordinary Ruhmkorff without change in its structure or connections.

To illustrate the principle, reference is made to Fig. 1, where *p n* represent connections to mains at, say, 110 volts difference of potential; I I is an iron wire core around which are wound two coils, one over the other, either of which may, of course, be the primary. The inner coil P in the figure is made the primary, and is wound with many turns of comparatively fine wire. For 110 volts it may have some thousands of turns and be wound with a wire safe for .5 to .75 ampere. The outside wire S may be coarse or fine. In the figure it is quite coarse and of relatively few turns, tion with one terminal of battery B to be charged, and which touches a stationary brush J, at or about the time of the break between brush G on the main segment of E. The battery B may have terminals by which it may furnish current while being charged.

Now let the break-wheels E and F be given rapid revolution, say, 10, 20 or 30 per second. The contact of brushes G and H with the main segment of E passes current for a certain considerable fraction of the revolution, at full line potential of 110 volts, through primary P. The current rises gradually during this period, and may at the end attain a value of one ampere, more or less. With slow revolution it would be limited by the resistance of P chiefly, but at rapid rates, the time constant of P acting as a self induction, determines the ultimate value of current before breaking. Upon the break of brush G with the main segment it touches the condenser segment, which is thereby put across the break; but the circuit of S is also closed by contact of segment on F with brush J. The condenser receives only a small charge on account of the circuit of S having been closed. In fact, the break at G with main segment of E would be nearly sparkless without the condenser C, but what slight self-induction is not wiped out by the mutual induction of the currents in S and P is very easily taken care of.

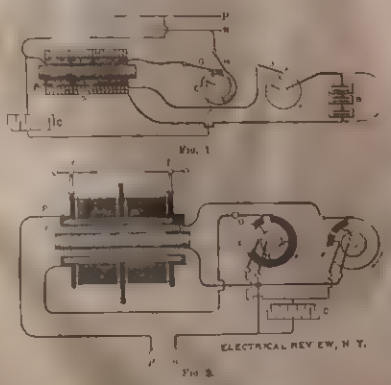


Fig. 1

Fig. 2

PROF. ELIHU THOMSON'S NEW FORM OF INDUCTION COIL

The magnetizing of the core I I or absorption of energy is by P, while delivery of energy by S, acting as if

secondary circuit. useful as a part itself, and having turns adds a consi the total potential The secondary is, fine wire of many well insulated thr

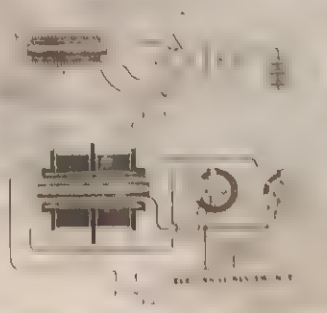
In Fig. 2 th marked S P, an coil P S, while marked S. The coils S P and P ondaries and pri This is, in fact, a of S P, but is onl P S, having been secondary circuit are at / /. The b like those of Fig. there is a much sl and a condenser as in E. There i circuit of S P, bu short-circuit at i time P S is broke current from line volts, or more. C circuit at brush G so to speak, are s circuit of S P, clo The consequence breaks no spark o of G E. As s has been fully es short circuit, and got entirely awa connections on E of F breaks the c is conveying a ve low potential. T put instantly no the spark flies be In this way a coil inch Ruhmkorff six-inch sparks, rent from a 110 one-half an ampe or clock work m the break-wheel made of fair dur racy in operation are only to be ob portioning of th done, and with result to be obtai

The discharge able from those korff. In fa might be use denser C as an

obtaining energy for the production of high potential discharges, like those of a Ruhmkorff coil for working Roentgen-ray vacuum tubes, and for such like purposes. The object, also, was to avoid the employment of banks of lamps or storage batteries, and to limit the energy consumed to only that amount required to work the coil itself. Furthermore, no larger condensers than those ordinarily used with an induction coil of equal capacity are needed, and no arc is lost, while the coil as a whole is still available as an ordinary Ruhmkorff without change in its structure or connections.

To illustrate the principle, reference is made to Fig. 1, where *p* represent connections to mains at, say, 110 volts difference of potential; I I is an iron wire core around which are wound two coils, one over the other, either of which may, of course, be the primary. The inner coil P in the figure is made the primary, and is wound with many turns of comparatively fine wire. For 110 volts it may have some thousands of turns and be wound with a wire safe for .5 to .7 ampere. The outside wire S may be coarse wire. In the figure it is quite coarse and of relatively few turns, as it is assumed to give low potential and large current. The coil S is so proportioned as to be practically almost but not quite at intervals by its load at B, which is three cells of storage battery in series, for example. The object is assumed to be that the batteries are charged by transference of energy from coil P to S at low potential in S. The coil S should have ample copper so as to lower its internal resistance as much as possible; the resistance of the cells B should be low, and the average voltage of discharge of S much superior to the counter electromotive force of B. Two synchronously revolving break pieces, E, F, which may, in fact, be combined into one, are used. F is for governing the intervals of passage of current in coil P and momentum of condenser C across the break or interruption periodically made between one terminal of P by a brush G and a metallic segment or F occupying a considerable arc on the periphery. Brush H connects to main *n*. Back of the main segment of F is a small condenser segment in continuous connect on with one side or foil of the condenser, and the other side is connected to the other terminal of P, or that leading direct from coil P. The contact maker and breaker E has a segment which is in continuous connec-

resistance of P varies, as at rates, the time constant of P acting as a self-induction, determines the ultimate value of current before breaking. Upon the break of brush G with the main segment it touches the condenser segment, which is thereby put across the break; but the circuit of S is also closed by contact of segment on F with brush J. The condenser receives only a small charge on account of the circuit of S having been closed. In fact, the break at G with main segment of F may be nearly sparkless without the denser C, but what slight sparkling tion is not wiped out by the induction of the currents in S and P is very easily taken care of.



Electric Furnace. New Form of Induction Coil.

The magnetizing of the core I I or absorption of energy is by P, while delivery of energy is by S, acting as if nearly on a closed circuit. This condition, however, does not involve much waste of energy if the ohmic resistance of the circuit of S be low enough. Here, then, is a transfer of energy from one circuit to another while the currents are direct currents in each circuit. To insure this being the case in S, the time of contact of segment on F with brush J must be selected so as not to permit any reversal; i. e., the break of said segment with K must be timed to be made on the cessation of the first impulse or discharge from S. To do this an ammeter, responding to direct currents only, placed in the battery circuit or in the leads from S, will indicate a maximum direct current when the segment F is of proper extent, and low under other conditions.

With the principles of the above apparatus in mind it is easy to understand the action of my new form of induction coil which may be described, briefly, as follows. The iron core I, Fig. 2, of the induction coil is wound with the ordinary coarse primary coil and terminals provided therefor. Then a coil of intermediate range, between the inner primary and the outer secondary, is wound. It is to be capable of being connected across a circuit of 110 volts or with coil P, Fig. 1. This coil is the true primary or energy supplying coil, but for convenience and saving of wire I prefer to connect it in as the under portion of the coil

[illegible] circuit of S P, [illegible] short-circuit at a [illegible] time P S is [illegible] current from [illegible] volts, or more [illegible] circuit at brush [illegible] has been fully established in S P short circuit, and after brush Q [illegible] one half [illegible] the work wheels [illegible] made of [illegible] rapid operation. [illegible] are only to be obtained [illegible] portioning of the parts [illegible] done and with a knowledge of [illegible] result to be obtained.

The discharges are rather [illegible] able from those of a similar Ruhmkorff. In fact the coil described might be used with the same condenser C as an ordinary Ruhmkorff coil energized by batteries. In this case the terminals of the coil secondary P S are disconnected, [illegible] half and battery is added between [illegible] G and terminal of S P which corresponds to J in Fig. 2. The break wheel F, when run with low potentials, [illegible] be immersed in water [illegible] way to facilitate sharp breaks, the apparatus has been very successfully run, at full output, for [illegible] little heavy oil on the break suffices. Also the flux of current in S P [illegible] be made by a magnet or break [illegible] circuit under water when the current has risen to a predetermined amount. In other words, it may be provided with the usual automatic breaker damped or adjusted not to get into mutual vibration. It will be seen from the above description that a new way of converting an induction coil or other transforming apparatus has been embodied, and that it consists in the rapid substitution of secondary and primary functions in the coil [illegible]

John H. and Harry L. Lamson have commenced [illegible] against the Akron, Bedford & Cleveland, Ohio, Electric Railroad Company, to compel application of alleged property rights. The plaintiffs say that they own 2,[illegible] feet of land on the line of the railway and they want money for their right in the steel which they claim [illegible] been occupied by the railway company.

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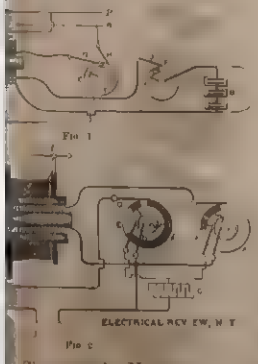

THOMSON'S NEW FORM OF INDUCTION COIL.

etizing of the core I I or
of energy is by P, while
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closed circuit. This con-
ever, does not involve

secondary circuit. It thus becomes useful as a part of the secondary itself, and having several thousand turns adds a considerable fraction to the total potential of the secondary. The secondary is, as usual, of quite fine wire of many thousands of turns, well insulated throughout.

In Fig. 2 the coarse coil is marked S P, and the intermediate coil P S, while that outside is marked S. The functions of the coils S P and P S are to act as secondaries and primaries alternately. This is, in fact, an essential function of S P, but is only incidental to coil P S, having been connected into the secondary circuit S, whose terminals are at *t t*. The break-wheels E F are like those of Fig. 1, except that in F there is a much shorter main segment and a condenser segment following, as in E. There is no battery in the circuit of S P, but it is put on dead short-circuit at intervals, just at the time P S is broken. Coil P S receives current from line at *p n*, at 100 to 200 volts, or more. On the break of this circuit at brush G the ampere turns, so to speak, are shifted suddenly into circuit of S P, closed on itself by J F. The consequence is that even at slow breaks no spark occurs at the rupture of G E. As soon as the current has been fully established in S P on short circuit, and after brush Q has got entirely away from all metallic connections on E, the main segment of F breaks the circuit of S P, which is conveying a very heavy current at low potential. The condenser C is put instantly across the break, and the spark flies between terminals *t t*. In this way a coil of the size of a six-inch Ruhmkorff gives a torrent of six-inch sparks, with an average current from a 110-volt line of about one-half an ampere. A simple motor or clock-work may be used to drive the break-wheels E F, which are made of fair diameter to insure accuracy in operation. The best results are only to be obtained when the proportioning of the parts is carefully done, and with a knowledge of the result to be obtained.

The discharges are indistinguishable from those of a similar Ruhmkorff. In fact, the coil described might be used with the same condenser C as an ordinary Ruhmkorff coil energized by batteries. In this case the terminals of the [illegible]

ELECTRIC RAILWAY NOTES.

McKinzie, Flint & W[illegible] have levied an attachment on [illegible] stock of the Citizens' Traction Company, of San Diego, Cal., owned by G. B. Kerper and C. W. Foote, to secure payment of an alleged debt of $607 20.

A trust mortgage for $552,000 from the Falls Road Electric Railway Company, of Baltimore, to the Maryland Trust Company, to secure the issue of an equal amount of bonds, has been recorded. The bonds will run for 50 years and will bear five per cent interest.

The Milwaukee, Wis., Electric Railway and Light Company has completed negotiations for the purchase of the property of the Waukesha Beach Electric Railway Company, consisting principally of the tracks, right of way, etc., from Waukesha to Pewaukee Lake.

The Waukesha, Wis., Electric Railway Company, Stutley I. Henderson, stockholder, has petitioned for the appointment of a receiver to wind up the affairs of the company, which was capitalized at $3,000,000. The company was incorporated a year ago, but only enough of the road was built to protect the franchise.

The Board of Public Works is considering a proposition of the Milwaukee, Wis., Electric Railway and Light Company for burying its feed wires along Grand avenue, except along the block between Tenth and Eleventh streets, where they are to remain overhead, because of the board's refusal to tear up the asphalt pavement.

The Postal Telegraph Company, of Portland, Me., has brought suit in the United States Circuit Court against the Portland & Yarmouth Railroad Company. The case arises out of the setting of the trolley poles of the Yarmouth road, the Postal Tele[illegible]

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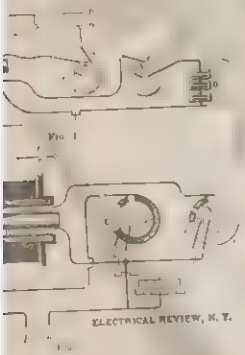

THOMSON'S NEW FORM OF INDUCTION COIL.

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of energy is by P, while
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closed circuit. This con-
rever, does not involve
e of energy if the ohmic
of the circuit of S be low
Here, then, is a transfer of
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uit. To insure this being
S, the time of contact of
F with brush J must be
as not to permit any re-
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he principles of the above
in mind it is easy to under-
action of my new form of
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I, Fig. 2, of the induction
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circuit of ... The consequence is that even a... breaks no spark occurs at the rupture of G E. As soon as the current has been fully established in S P on short circuit, and after brush Q has got entirely away from all metallic connections on E, the main segment of F breaks the circuit of S P, which is conveying a very heavy current at low potential. The condenser C is put instantly across the break, and the spark flies between terminals *t t*. In this way a coil of the size of a six-inch Ruhmkorff gives a torrent of six-inch sparks, with an average current from a 110-volt line of about one-half an ampere. A simple motor or clock-work may be used to drive the break-wheels E F, which are made of fair diameter to insure accuracy in operation. The best results are only to be obtained when the proportioning of the parts is carefully done, and with a knowledge of the result to be obtained.

The discharges are indistinguishable from those of a similar Ruhmkorff. In fact, the coil described might be used with the same condenser C as an ordinary Ruhmkorff coil energized by batteries. In this case the terminals of the coil section P S are disconnected, brush J lifted and battery inserted between brush G and terminal of S P, which goes to J in Fig. 2. The break-wheel E or F, when run with low potentials, may be immersed in water in the usual way to facilitate sharp breaks, but the apparatus has been very successfully run, at full output, dry, or a little heavy oil on the break suffices. Also, the flux of current in S P may be made by a magnet to break its own circuit under water when the current has risen to a predetermined amount. In other words, it may be provided with the usual automatic break, damped or adjusted not to get into tremulous vibration. It will be seen from the above description that a new way of energizing an induction coil or other transforming apparatus has been embodied, and that it consists in the rapid substitution of secondary and primary functions in the coil S P.

John H. and Harry L. Lamson have commenced a suit against the Akron, Bedford & Cleveland, Ohio, Electric Railroad Company, to compel appropriation of alleged property rights. The plaintiffs say that they own 2,000 feet of land on the line of the railway, and they want money for their rights in the street, which they claim have been usurped by the railway company.

stockholder, has ... appointment of a receiver to wind up the affairs of the company, which was capitalized at $3,000,000. The company was incorporated a year ago, but only enough of the road was built to protect the franchise.

The Board of Public Works is considering a proposition of the Milwaukee, Wis., Electric Railway and Light Company for burying its feed wires along Grand avenue, except along the block between Tenth and Eleventh streets, where they are to remain overhead, because of the board's refusal to tear up the asphalt pavement.

The Postal Telegraph Company, of Portland, Me., has brought suit in the United States Circuit Court against the Portland & Yarmouth Railroad Company. The case arises out of the setting of the trolley poles of the Yarmouth road, the Postal Telegraph Company claiming that the trolley wires have been placed so near to the telegraph wires as to make the latter nearly useless for the transmission of messages.

Mrs. Luther Lane has brought an odd suit against the Cleveland, Ohio, Electric Railway Company. She claims damages for two separate causes of action, but both of them involve the same state of facts, except that they occurred several years apart. The first cause arose April 18, 1894. Plaintiff charges that she was on one of the defendant's cars and wished to alight at the corner of Dunham and Lexington avenues. She says that the car was started before she could get off, and that she was thrown to the ground, injuring her arm, shoulder and hip, and suffering great nervous shock from her fall. For this she claims $2,500. May 24, 1897, at the same corner, in one of defendant's cars, she charges that she was again thrown down in the same way, and injured the same shoulder, arm and hip. Damages in this case are laid at $3,000. She charges that her injuries were so severe that she has not been able to attend to her duties as a housewife since.

having been closed. In fact, the break at G with main segment of E would be nearly sparkless without the condenser C, but what slight self-induction is not wiped out by the mutual induction of the currents in S and P is very easily taken care of.

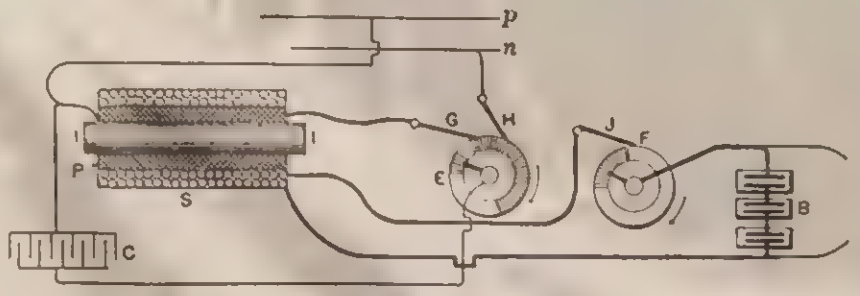

Fig. 1.

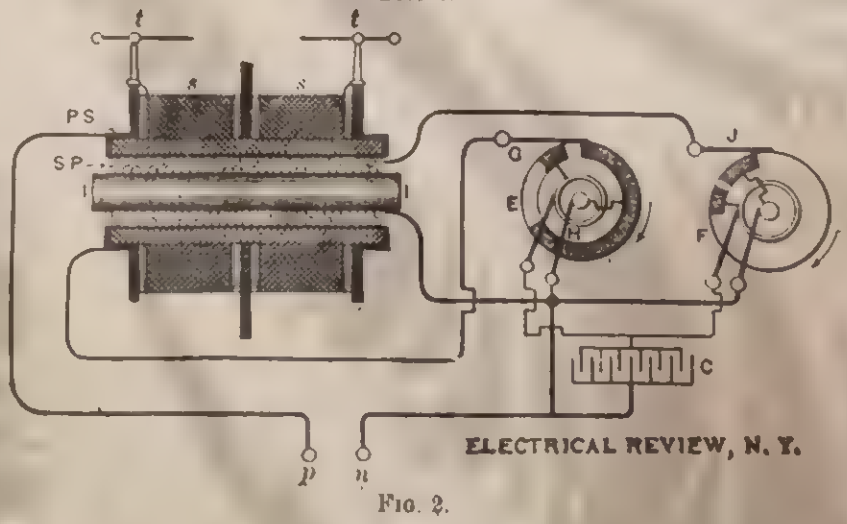

Fig. 2.

Prof. Elihu Thomson's New Form of Induction Coil.

The magnetizing of the core I I or absorption of energy is by P, while delivery of energy is by S, acting as if nearly on a closed circuit. This con-

PERSONAL.

[illegible] Learned, of New [illegible] a retired New York [illegible] recently elected president [illegible] St. Street Railway [illegible]

[illegible] well known in [illegible] is interested as a [illegible] New York city [illegible] patents of Dr. Foward, [illegible] refine crude oil [illegible] high-grade asphalt [illegible]

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[illegible] McLean, Professor of [illegible] New York city [illegible] as a delegate [illegible] of the British [illegible] the Advancement of [illegible] held in Toronto. [illegible] on his way [illegible]

[illegible] Wilson, formerly [illegible] Telephone Com- [illegible]

Carbon Patents [illegible]

[illegible] Decision [illegible]

TESLA ON RO[illegible]EN RAYS

idea of the pr[illegible]ion of the radiations [illegible] discovered by Lenard [illegible] Roentgen. It may be comprised [illegible] the statement that the streams of minute material particles projected from an electrode with great velo[illegible] in encountering obstacles wherever they may be, within the bulb, in the air or other medium or in the sensitive layers themselves, give rise to ra[illegible] possessing many [illegible] properties of those known as [illegible] [illegible]ation of these rays is undoubtedly demonstrated as true, it will have most im- [illegible] to again critically examine many phenomena which are presently attributed to transverse ether waves, which may lead to a radical modification of existing views and theories in regard to these phenomena, if not as to their essence so, at least, as to the mode of their production.

My effort to arrive at an answer to the third of the [illegible] which exists between the Lenard and Roentgen rays. The photographs bearing on this point were exhibited at a [illegible] of the New York Academy of Sciences—before referred to [illegible] but, unfortunately [illegible] of my address, [illegible] of thought on [illegible] I omitted what was [illegible] to describe [illegible] in which these photographs [illegible] overnight [illegible] the day following [illegible]

[illegible] purpose, some impressions in [illegible] have led me to the conclusion that in lightning discharges Lenard and Roentgen rays must be generated [illegible] ordinary atmospheric pressure.

[illegible] the construction [illegible]

[illegible] Fig. [illegible] the aluminum cap [illegible]

[illegible] ow, and any potential or [illegible] pressure is obtainable [illegible] found that [illegible]

outside, as is frequently done. Long experience has demonstrated that it is practically impossible to maintain a high vacuum in a tube with an outside cap. The only way I have been able to do this in a fa[illegible] air, for instance, and observing the following precautions. The air jet is first turned on slightly and upon [illegible] [illegible]ted. The current [illegible] and also the ai[illegible] [illegible] reduced and bot[illegible] that [illegible]

[illegible] are, however, the [illegible] the aluminum [illegible] ing in of the cap. The [illegible] latter may be one thirty-second or even one-sixteenth of an inch thick, and in such case the central portion may be thinned down by a counter- [illegible] about one fourth of an inch [illegible] as far as it is possible [illegible] the sheet. The [illegible] down may the [illegible]

[illegible] with [illegible] I have [illegible] with a [illegible] aluminum [illegible] of an inch thick, [illegible] cap by means of a [illegible]

[illegible] the raw [illegible] operating [illegible] with the [illegible] of the [illegible] few [illegible] for [illegible] parts [illegible] I have taken [illegible] tubes and [illegible] previous [illegible] in the [illegible] safety [illegible] taking [illegible] Fig. 4.

NIKOLA TESLA.

New York [illegible]

Electric Light Plant Wanted.

Mr. [illegible] of the [illegible] Company, of [illegible] writes to [illegible] Review [illegible] date of [illegible] as follows: [illegible]

TESLA ON ROENTGEN RAYS.

(Concluded from page 67.)

idea of the process of generation of the radiations which have been discovered by Lenard and Roentgen. It may be comprised in the statement that the streams of minute material particles projected from an electrode with great velocity in encountering obstacles wherever they may be, within the bulb, in the air or other medium or in the sensitive layers themselves, give rise to rays or radiations possessing many of the properties of those known as light. If this physical process of generation of these rays is undoubtedly demonstrated as true, it will have most important consequences, as it will induce physicists to again critically examine many phenomena which are presently attributed to transverse ether waves, which may lead to a radical modification of existing views and theories in regard to these phenomena, if not as to their essence so, at least, as to the mode of their production.

My effort to arrive at an answer to the third of the above questions led me to the establishment, by actual photographs, of the close relationship which exists between the Lenard and Roentgen rays. The photographs bearing on this point were exhibited at a meeting of the New York Academy of Sciences—before referred to—April 6, 1897, but, unfortunately, owing to the shortness of my address, and concentration of thought on other matters, I omitted what was most important; namely, to describe the manner in which these photographs were obtained, an oversight which I was able to only partially repair the day following. I did, however, on that occasion illustrate and describe experiments, in which was shown the deflectibility of the Roentgen rays by a magnet, which establishes a still closer relationship, if not identity, of the rays named

described, in which the primary is operated by the discharge of a condenser. With such an instrument any desired suddenness of the impulses may be secured, there being practically no limit in this respect, as the energy accumulated in the condenser is the most violently explosive agent we know, and any potential or electrical pressure is obtainable. Indeed, I found that in increasing the suddenness of the electro motive impulses through the tube—without, however, increasing, but rather diminishing the total energy conveyed to it—phosphorescence was observed and rays began to appear, first the feebler Lenard rays and later, by pushing the suddenness far enough, Roentgen rays of great intensity, which enabled me to obtain photographs showing the finest texture of the bones. Still, the same tube, when again operated with the ordinary coil of a low rate of change in the primary current, emitted practically no rays, even when, as before stated, much more energy, as judged from the heating, was passed through it. This experience, together with the fact that I have succeeded in producing by the use of immense electrical pressures, obtainable with certain apparatus designed for this express purpose, some impressions in free air, have led me to the conclusion that in lightning discharges Lenard and Roentgen rays must be generated at ordinary atmospheric pressure.

At this juncture I realize, by a perusal of the preceding lines, that my scientific interest has dominated the practical, and that the following remarks must be devoted to the primary object of this communication—that is, to giving some data for the construction to those engaged in the manufacture of the tubes and, perhaps, a few useful hints to practicing physicians who are dependent on such information. The foregoing was, nevertheless, not lost for this object, inasmuch as it has shown how much the result obtained depends on the proper construction of the instruments, for, with ordinary implements, most of the above observations could

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To bring out clearly the significance of the photographs in question, I would recall that, in some of my previous contributions to scientific societies, I have endeavored to dispel a popular opinion before existing that the phenomena known as those of Crookes were dependent on and indicative of high vacua. With this object in view, I showed that phosphorescence and most of the phenomena in Crookes bulbs were producible at greater pressures of the gases in the bulbs by the use of much higher or more sudden electro-motive impulses. Having this well demonstrated fact before me, I prepared a tube in the manner described by Lenard in his first classical communication on this subject. The tube was exhausted to a moderate degree, either by chance or of necessity, and it was found that, when operated by an ordinary high tension coil of a low rate of change in the current, no rays of any of the two kinds could be detected, even when the tube was so highly strained as to become very hot in a few moments. Now, I expected that, if the suddenness of the impulses through the bulb were sufficiently increased, rays would be emitted. To test this I employed a coil of a type which I have repeatedly [illegible] This experience, together with the fact that I have succeeded in producing by the use of immense electro[illegible] pressure[illegible], obtainable with [illegible] apparatus [illegible] for the express purpose, some impressions in free air, have led me to the conclusion that in high vacua the Lenard and Röntgen rays [illegible] generated at [illegible] pressure.

At this juncture I realize by perusal of the preceding that scientific interest has long ceased practical, and that the following remarks must be devoted to the preliminary object of this communication—that is, to giving some data for the instruction of those engaged in the manufacture of the tubes and, perhaps, a few useful hints to practicing physicians who are dependent upon such information. The foregoing was, nevertheless, not lost for this object, inasmuch as it has shown how much the result obtained depends on the proper construction of the instruments, for, with ordinary implements, most of the above observations could not have been made.

I have already described the form of tube illustrated in Fig. 1, and in Fig. 2 another still further improved design is shown. In this case the aluminum cap A, instead of having a straight bottom as before, is shaped spherically, the center of the sphere coinciding with that of the electrode *e*, which itself, as in Fig. 1, has its focus in the center of the window of cap A, as indicated by the dotted lines. The aluminum cap A has a tinfoil ring *r*, as that in Fig. 1, or else the metal of the cap is spun out on that place so as to afford a bearing of small surface between the metal and the glass. This is an important practical detail as, by making the bearing surface small, the pressure per unit of area is increased and a more perfect joint made. The ring *r* should be first spun out and then ground to fit the neck of the bulb. If a tinfoil ring is used instead, it may be cut out of one of the ordinary tinfoil caps obtainable in the market, care being taken that the ring is very smooth.

In Fig. 3 I have shown a modified design of tube which, as the two types before described, was comprised in the collection I exhibited. This, as will be observed, is a double-focus tube, with impact plates of iridium alloy and an aluminum cap A opposite the same. The tube is not shown because of any originality in design, but simply to illustrate a practical feature. It will be noted that the aluminum caps in the tubes described are fitted inside of the necks and not [illegible] this precaution if pr[illegible] is taken in their preparat[illegible] inserting the cap the latter [illegible] down as low as it is deemed [illegible] without endangering the g[illegible] it is then gently pushed in [illegible] of the tube, taking care th[illegible] straight.

The two most important [illegible] in the manufacture of suc[illegible] are, however, the thinning [illegible] the aluminum window and [illegible] ing in of the cap. The me[illegible] latter may be one thirty-s[illegible] even one-sixteenth of an i[illegible] and in such case the centra[illegible] may be thinned down by [illegible] sink tool about one-fourth [illegible] in diameter as far as it [illegible] without tearing the shee[illegible] further thinning down ma[illegible] done by hand with a scra[illegible] and, finally, the metal [illegible] gently beaten down so as [illegible] close the pores which migh[illegible] slow leak. Instead of pro[illegible] this way I have employed [illegible] a hole in the center, whi[illegible] closed with a sheet of pure [illegible] a few thousandths of an i[illegible] riveted to the cap by m[illegible] washer of thick metal, but [illegible] were not quite as satisfacto[illegible]

In sealing the cap I hav[illegible] the following proceed[illegible] T[illegible] fastened on the pump in [illegible] position and exhausted ur[illegible] manent conditions reach[illegible] degree of exhaust[illegible] is a r[illegible] perfection of the joint. T[illegible] usually considerable, but th[illegible] serious a defect as might b[illegible] Heat is now gradually appl[illegible] tube by means of a gas st[illegible] temperature up to about [illegible] point of sealing wax is reac[illegible] space between the cap and [illegible] is then filled with sealing w[illegible] quality; and when the la[illegible] to boil, the temperature is[illegible] allow its settling in the ca[illegible] heat is then again increase[illegible] process of heating and coo[illegible] peated several times until [illegible] cavity, upon reduction of t[illegible] ature, is found to be filled [illegible] with the wax, all bubbles [illegible] appeared. A little more w[illegible] put on the top and the [illegible] carried on for an hour or [illegible] ing to the capacity of the [illegible] application of moderate [illegible] below the melting point of [illegible]

A tube prepared in th[illegible] will maintain the vacuum [illegible] and will last indefinitely, [illegible] used for a few months, it n[illegible] ally lose the high vacuu[illegible] can be quickly worked [illegible] ever, if after long use i[illegible] necessary to clean the t[illegible] easily done by gently war[illegible] taking off the cap. I[illegible]

described, in which the primary is operated by the discharges of a condenser. With such an instrument any desired suddenness of the impulses may be secured, there being practically no limit in this respect, as the energy accumulated in the condenser is the most violently explosive agent we know, and any potential or electrical pressure is obtainable. Indeed, I found that in increasing the suddenness of the electro motive impulses through the tube—without, however, increasing, but rather diminishing the total energy conveyed to it—phosphorescence was observed and rays began to appear, first the feebler Lenard rays and later, by pushing the suddenness far enough, Roentgen rays of great intensity, which enabled me to obtain photographs showing the finest texture of the bones. Still, the same tube, when again operated with the ordinary coil of a low rate of change in the primary current, emitted practically no rays, even when, as before stated, much more energy, as judged from the heating, was passed through it. This experience, together with the fact that I have succeeded in producing by the use of immense electrical pressures, obtainable with certain apparatus designed for this express purpose, some impressions in free air, have led me to the conclusion that in lightning discharges Lenard and Roentgen rays must be generated at ordinary atmospheric pressure.

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I have already described the form of tube illustrated in Fig. 1, and in Fig. 2 another still further improved form is shown. In this case the aluminum cap A, instead of having a straight bottom as before, is shaped spherically, the center of the sphere coinciding with that of the electrode, which itself, as in Fig. 1, has its focus in the center of the sphere. The cap is fastened to the tube by means of a metal collar, which is cemented to the glass outside, as is frequently done. Long experience has demonstrated that it is practically impossible to maintain a high vacuum in a tube with an outside cap. The only way I have been able to do this in a fair measure is by cooling the cap by a jet of air, for instance, and observing the following precautions. The air jet is first turned on slightly and upon this the tube is excited. The current through the latter, and also the air pressure, are then gradually increased and brought to the normal working condition. Upon completing the experiment the air pressure and current through the tube are both gradually reduced and both so manipulated that no great differences in temperature result between the glass and aluminum cap. If these precautions are not observed the vacuum will be immediately impaired in consequence of the uneven expansion of the glass and metal.

With tubes, as these presently described, it is quite unnecessary to observe this precaution if proper care is taken in their preparation. In inserting the cap the latter is cooled down as low as it is deemed advisable without endangering the glass and it is then gently pushed in the neck of the tube, taking care that it sets straight.

The two most important operations in the manufacture of such a tube are, however, the thinning down of the aluminum window and the sealing in of the cap. The metal of the latter may be one thirty-second or even one-sixteenth of an inch thick, and in such case the central portion may be thinned down by a countersink tool about one fourth of an inch in diameter as far as it is possible without tearing the sheet. The further thinning down may then be done by hand with a scraping tool; and, finally, the metal should be gently beaten down so as to surely close the pores which might permit a slow leak. Instead of proceeding in this way I have employed a cap with a hole in the center, which I have closed with a sheet of pure aluminum a few thousandths of an inch thick, riveted to the cap by means of a washer of thick metal, but the results were not quite as satisfactory.

In sealing the cap I have adopted the following procedure. The tube is fastened on the pump in the proper position and exhausted until a permanent condition is reached. The degree of exhaustion is a measure of perfection of the joint. The leak is usually unmeasurable, but this is not so serious a defect as might be thought, as may be done first with acid, then with highly diluted alkali, next with distilled water, and finally with pure rectified alcohol.

These tubes, when properly prepared, give impressions much sharper and reveal much more detail than those of ordinary make. It is important for the clearness of the impressions that the electrode should be properly shaped, and that the focus should be exactly in the center of the cap or slightly inside. In fitting in the cap, the distance from the electrode should be measured as exactly as possible. It should also be remarked that the thinner the window, the sharper are the impressions, but it is not advisable to make it too thin, as it is apt to melt in a point on turning on the current.

The above advantages are not the only ones which these tubes offer. They are also better adapted for purposes of examination by surgeons, particularly if used in the peculiar manner illustrated in diagrams Fig. 3 and Fig. 4, which are self-explanatory. It will be seen that in each of these the cap is connected to the ground. This decidedly diminishes the injurious action and enables also to take impressions with very short exposures of a few seconds only at close range, inasmuch as, during the operation of the bulb, one can easily touch the cap without any inconvenience, owing to the ground connection. The arrangement shown in Fig. 4 is particularly advantageous with a form of single terminal, which coil I have described on other occasions and which is diagramatically illustrated, P being the primary and S the secondary. In this instance the high-potential terminal is connected to the electrode, while the cap is grounded. The tube may be placed in the position indicated in the drawing, under the operating table and quite close, or even in contact with the body of the patient, if the impression requires only a few seconds as, for instance, in examining parts of the members. I have taken many impressions with such tubes and have observed no injurious action, but I would advise not to expose for longer than two or three minutes at very short distances. In this respect the experimenter should bear in mind what I have stated in previous communications. At all events it is certain that, in proceeding in the manner described, additional safety is obtained and the process of taking impressions much quickened. To cool the cap, a jet of air may be used, as before stated, with a small

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In Fig. 3 I have shown a modified design of tube which, as the two types before described, was comprised in the collection I exhibited. This, as will be observed, is a double-focus tube, with impact plates of iridium alloy and an aluminum cap A opposite the same. The tube is not shown because of any originality in design, but simply to illustrate a practical feature. It will be noted that the aluminum caps in the tubes described are fitted inside of the necks and not [illegible] observed the vacuum will be immediately impaired in consequence of [illegible].

[illegible] without [illegible] and it is then gently pushed in the neck of the tube, taking care that it sets straight.

The two most important operations in the manufacture of such a tube are, however, the thinning down of the aluminum window and the sealing in of the cap. The metal of the latter may be one thirty-second or even one-sixteenth of an inch thick, and in such case the central portion may be thinned down by a countersink tool about one-fourth of an inch in diameter as far as it is possible without tearing the sheet. The further thinning down may then be done by hand with a scraping tool; and finally the metal should be gently beaten down so as to surely close the pores which might permit a slow leak. Instead of proceeding in this way I have employed a cap with a hole in the center, which I have closed with a sheet of pure aluminum a few thousandths of an inch thick, riveted to the cap by means of a washer of thick metal, but the results were not quite as satisfactory.

In sealing the cap I have adopted the following procedure: The tube is fastened on the pump in the proper position and exhausted until a permanent condition is reached. The degree of exhaustion is a measure of perfection of the joint. The leak is usually considerable, but this is not so serious a defect as might be thought. Heat is now gradually applied to the tube by means of a gas stove until a temperature up to about the boiling point of sealing wax is reached. The space between the cap and the glass is then filled with sealing wax of good quality, and, when the latter begins to boil, the temperature is reduced to allow its settling in the cavity. The heat is then again increased, and this process of heating and cooling is repeated several times until the entire cavity, upon reduction of the temperature, is found to be filled uniformly with the wax, all bubbles having disappeared. A little more wax is then put on the top and the exhaustion carried on for an hour or so, according to the capacity of the pump, by application of moderate heat much below the melting point of the wax.

A tube prepared in this manner will maintain the vacuum very well, and will last indefinitely. If not used for a few months, it may gradually lose the high vacuum, but it can be quickly worked up. However, if after long use it becomes necessary to clean the tube, this is easily done by gently warming it and taking off the cap. The cleaning

The above advantages are not the only ones which these tubes offer. They are [illegible] better adapted for [illegible] examination [illegible] [illegible] in the [illegible] dia[gram] Fig. 3 [illegible] self-explanatory. [illegible] these the cap [illegible] to the ground. [illegible] decidedly [illegible] the [illegible] to [illegible] very short ex[posures] of a few seconds [illegible] at close range [illegible] during the operation [illegible] the cap without any inconvenience, owing to the ground connection. The arrangement shown in Fig. 4 is [illegible] advantageous with a form of single terminal, which [illegible] I have [illegible] on other occasions and which is diagrammatically illustrated, P being the primary and S the secondary. In this instance the high potential terminal is connected to the electrode, while the cap is grounded. The tube may be placed in the position indicated in the drawing, under the operating table and quite close, or even in contact with the body of the patient, if the impression requires only a few seconds, as, for instance, in examining parts of the members. I have taken many impressions with such tubes and have observed no injurious action, but I would advise not to expose for longer than two or three minutes at very short distances. In this respect the experimenter should bear in mind what I have stated in previous communications. At all events it is certain that, in proceeding in the manner described, additional safety is obtained and the process of taking impressions much quickened. To cool the cap a jet of air may be used, as before stated, or else a small quantity of water may be poured in the cap each time when an impression is taken. The water only slightly impairs the action of the tube, while it maintains the window at a safe temperature. I may add that the tubes are improved by providing a [illegible] the electrode a metallic coating C, shown in Fig. 3 and Fig. 4.

NIKOLA TESLA.

New York, August [illegible]

Electric Light Plant Wanted.

Mr. T. J. Lillard, treasurer of the Elkin Manufacturing Company, of Elkin, Surry County, N. C., manufacturers of cotton yarns, twines, etc., writes to the ELECTRICAL REVIEW, under date of August 7, as follows:

"We want prices and estimates on a [illegible] light incandescent dynamo, switchboard, wire and everything used, to light the town of Elkin with, say [illegible] candle-power street lights, and for [illegible] stores and residences with eight lights each.

Electrical.... Patents.

other station a group of polarization ... in one of the ground branches

J. W. Gibboney

... Telephone ... W. Gibboney,

having upon ... a line circuit and a ... in a local circuit of ... secondary to said primary

... currents generated, ... independent ... each set of ... field coil of its magnet

pencil and a ... wheels in which ... track on which

587,226. Telephone ... O'Connell, Chicago, Ill.

ISSUED AUGUST 3, 1897.

587,406. Apparatus for telephone switchboards. C. E. Scribner, Chicago, Ill.

resistance in series with the ... and a variable resistance in the ... and in shunt with the patient or operator circuit.

587,507. Central office switchboard system. W. S. Harrison, Chicago, Ill.

... Electric signal device for elevators. ... Brooks, St. Louis, Mo.

Tesla's System of Energy Transmission to a Distance Without Wires.

In view of the many reports which are appearing in the sensational dailies about Tesla's work, it appears only justice to this earnest and modest worker that we should publish the following sensible statement reported in such a competent and carefully edited journal as the *Sun*, of this city. The statement is reported as follows:

... repeatedly shown ... personal friends ... any detail must have ... a matter of fact ... laboratory ...

587,406 Apparatus for telephone switchboards. C. F. Scribner, Chicago, Ill.

587,421 Electric arc lamp; S. Bergmann, New York, N. Y.

587,433 [illegible] signaling apparatus. M. Du Perow, Washington, D. C.

587,445 [illegible] telephone system; M. [illegible], Paris, France.

587,4[illegible] Electro therapeutic apparatus; F. Geiger, Philadelphia, Pa.—A main circuit, a patient or operator circuit; a fixed resistance in series with the operator circuit, and a variable resistance in the main circuit, [illegible] in shunt with the patient or operator circuit.

587,437 Apparatus for manufacturing [illegible] of [illegible] by [illegible] H. [illegible] Hutter, Liverpool, England.—A cathode consisting of a metallic vessel having a porous protective lining.

587,441 Regulating apparatus for electrically driven machinery; W. H. Knight, Newton, Mass.

587,442 Method of regulating electrically driven mechanism; W. H. Knight, Newton, Mass.

587,458 Electric switch; H. W. Smith, Pittsfield, Mass.—Comprises a block, a [illegible] undercut recess therein, a contact plate bent to correspond substantially with said recess, and a pin within said recess to secure said plate in place.

587,465 Electric arc lamp; E. F. Taylor, West Chester, Pa.

587,467 Telephone central station [illegible] ing circuit; G. K. Thompson, M[illegible], Mass.

587,[illegible] Central office switchboard system; W. S. Harrison, Chicago, Ill.

587,[illegible] Electric signal device for elevators; [illegible] Raacke, St. Louis, Mo.

587,[illegible] Electric motor or dynamo electric machine; R. [illegible] Lundell, Brooklyn, N. Y. [illegible]

587,534 [illegible] A [illegible] New York, N. Y.

587,[illegible] [illegible] signal box. A. T. White, [illegible], Ohio.

587,568 Electric heating apparatus; G. D. B[illegible], Mass. [illegible] tank [illegible] contents of the [illegible] adjacent [illegible]

587,576 Dynamo electric machine; C. M. Green, Cleveland, Ohio. [illegible]

587,601 Device for closing [illegible]; H. Lowe, New York, N. Y.

587,[illegible] Electric contact; A. J. Moxham, [illegible], Ohio. A metallic cover [illegible] perforation [illegible] secured [illegible] perforation, but [illegible] from said projections.

587,614 Electric wire holder; C. J. Strat[illegible] [illegible]

587,642 Electric contact box; W. M. [illegible] Johnstown, Pa. Comprises a fixed [illegible] contact carrying armature [illegible] no secured to said armature [illegible] portion of the mechanism.

587,649 Electrotherapeutic chair; E. F. Davis, West Caton, N. Y.—A chair having means for passing an electric current through a person seated thereon, a foot rest, a seat [illegible] the weight of [illegible]

Tesla's System of Energy Transmission to a Distance Without Wires.

In view of the many reports which are appearing in the sensational dailies about Tesla's work, it appears only justice to this earnest and modest worker that we should publish the following sensible statement reported in such a competent and carefully edited journal as the *Sun*, of this city. The statement is reported as follows in its evening issue of August 4:

Nikola Tesla this morning denied the report that he had announced the completion of his discovery of a method of telegraphy without wires. [illegible] reports of the progress of the [illegible] had been published from time to time, he said. His experiments had been repeatedly shown in strict confidence to some of his personal friends, but the publication of them in any detail must have been a violation of confidence. As a matter of fact, no experiments were made at the laboratory yesterday. The inventor, however, was willing to give some account of his work up to the present time.

"In a lecture delivered about four years ago," he said, "before the National Electric Light Association in St. Louis, that was in March, 1893—I explained a certain scheme for producing electrical [illegible] with the object of transmitting [illegible] messages [illegible] from place to place [illegible] the use of any wires.

"[illegible] that [illegible] one of its terminals [illegible] and [illegible] an insulated [illegible] preferably be at a great height where the air is less dense and transmits more easily the disturbance.

"Such an apparatus is then exactly what in [illegible] a suction pump. Periodically it draws electricity out and forces it again into the earth, thereby altering rhythmically the electrostatic potential in the earth as well as in the air.

"This scheme I had, as a matter of fact, conceived many years before. But I had previously lacked the courage to present it to the scientific world. At the time of the St. Louis lecture I had already seen such results that I gathered courage enough to announce the project seriously.

"Shortly afterward, on my return to this city, I actually demonstrated by means of an improved apparatus that I was [illegible] to create a disturbance in the manner [illegible] in the lecture.

"It [illegible] pleasure and excitement at this success [illegible] from showing the first experiments to a few intimate friends. When later my laboratory [illegible], and the first instrument with which I had [illegible] my demonstration, [illegible] other, was destroyed, it was no small [illegible] that a few [illegible] had seen the first evidence of my success. They were my friends, of course, as the experiments that I have made [illegible] day have been [illegible] confidence and [illegible] that no popular [illegible] of them [illegible] I have [illegible] my results.

"It appeared [illegible] years ago that [illegible] result [illegible] possible [illegible] to attain [illegible] as I have [illegible] merely the use of a properly constructed [illegible] connected with the ground and [illegible] a sensitive [illegible] at a distance [illegible] at a considerable height [illegible]

"[illegible] disturbance [illegible] produced [illegible] which I am [illegible] been perfect [illegible] sparks [illegible] apparatus [illegible] I now [illegible] [illegible] the [illegible]

"[illegible] is very high [illegible] I should [illegible]

"[illegible] what I say [illegible] interests [illegible] there are many [illegible] [illegible] electrical [illegible] But it is [illegible] perfectly possible [illegible] exposure by a suitably arranged apparatus at a distance yet this fact will not revolutionize warfare. The enemy could avail himself of similar methods with like results."

The Mountain Chautauqua.

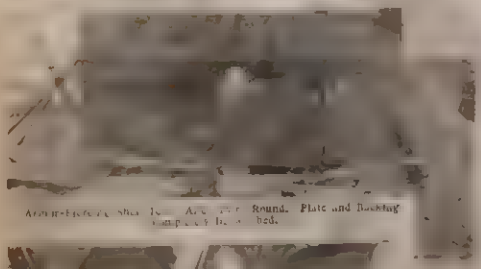
[illegible] at Mountain Lake Park, Md., opens its session August [illegible] and [illegible] August 24. It is the most [illegible] summer resort in [illegible]. Its height 2,800 feet above sea [illegible] climate and unsurpassed [illegible] view. Five well appointed [illegible] open their doors [illegible] at from $7 to $12 per week. [illegible] of important schools [illegible] lecturers [illegible] entertainers [illegible] programme [illegible]. Here is a chance [illegible] profit with your vacation.

Mountain Lake Park is located on the main line of the B. & O. Railroad, and as [illegible] fast trains stop at the Park during the summer, patrons have the advantage of their superb train service between the East and the West.

[illegible] Round [illegible]

SCIENTIFIC AMERICAN

NEW YORK, NOVEMBER 30, 1901



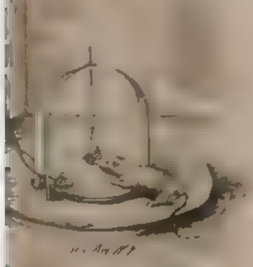
TESTS OF HIGH EXPLOSIVE SHELL AT SANDY HOOK.—[See page

...d deposit ... frequently clogs ... the replenishing of ... inkwell pictured is free ... has its long leg extending ... ort leg in communication. A port pierces the wall and communicates with ... veen its ends. A valve

...IPHON INKWELL.

... will escape ... ort. In order to retain ... the bulb, ... the short leg of ... inkwell at a dis... amount of ...

... conceived the ... electricity and has ... trap. The base ...



...TRICAL MOUSE-TRAP.

...e suspended platform ... leap upon the platform ... circuit is closed and the ... gh its body.

... ball-bearing wheel ... a ... P. Vaughan, of Perry,

... electric saw and jimmy ... companion carried an electric lamp ... of the old fashioned oil-lantern. The two burglars were well dressed and had good manners. They are said to be skillful mechanics. The police say that the electric bludgeon is one of the most dangerous weapons ever seen."

Tesla's Recent Patents.

Nikola Tesla has received several patents for a "Method of Intensifying and Utilizing Effects Transmitted Through Natural Media." In one of his systems Tesla varies the potential point or region of the earth by imparting to it intermittent or alternating electrifications through one of the terminals of a suitable source of electrical disturbances which, to heighten the effect, has its other terminal connected with an insulated body, preferably of large surface and at an elevation. Electrifications communicated to the earth spread in all directions, reaching a circuit which generally has its terminals arranged and connected similarly to those of the transmitting source, and which operates upon a highly sensitive receiver. Another of Tesla's methods is based upon the fact that the atmospheric air, which behaves as an excellent insulator to currents generated by ordinary apparatus, becomes a conductor under the influence of currents or impulses of enormously high electromotive force. By such means air strata which are easily accessible, are rendered available for the production of many desired effects at distances. Although either method may be employed it is obviously desirable that the disturbance should be as powerful as possible and should be transmitted with a minimum loss. The loss reduces greatly both the intensity and the number of the co-operative impulses, and since the initial intensity of each of these is necessarily limited, only an insignificant amount of energy is thus available for a single operation of the receiver. Furthermore the energy obtained through the co-operation of the impulses is in the form of an extremely rapid vibration and unsuitable for the operation of ordinary receivers. To overcome these limitations of the two methods mentioned Tesla reproduces arbitrarily varied or intermittent disturbances or effects, transmits these disturbances through the air to a distant receiving station, utilizes the energy derived from such disturbances at the receiving station to charge a condenser, and uses the accumulated potential so obtained to operate a receiving device.

The apparatus which is employed at the receiving station consists in the combination of a storage device included in a circuit, connection points at a distance from the source of the disturbances and between which a difference of potential is created by such disturbances; a receiving circuit connected with the storage device, a receiver included in the receiving circuit, and a mechanism for closing the receiving circuit at any desired moment, thereby causing the receiver to be operated by the energy with which the storage device has been charged.

In another method the energy stored is not, as in the preceding ... energy of

... tion of ... rendered us ... energy is ... nected with one of the armat... positively electrified by the inv... electricity is carried off from ... connecting it with the ground, ... ergy is discharged through a

Recent Improvements in ...

Several patents have recent... ... States to Walther Ne... and Marshall W. Hanks for p... signed to overcome various d... noticeable in the Nernst la... ... intends to use se... ... heating of a single ... a single spiral suffic... ... uniformity, but ... are to be sta... ... distributed to ...

... several heaters ... a single spiral ... ... the practical ... of glowers having ... employ a balla... ... Nernst has likewise i... ... These compos... ... of zirconium, ... groups ... effective and easily pr... Nernst lamp glowers ... circuits of a give... patent granted to Mr.

[illegible] inventor has conceived the [illegible] is by electricity and has [illegible] mousetrap. The base

ELECTRICAL MOUSE TRAP

[illegible] and the superposed platform [illegible] rat leaps upon the platform the circuit is closed and the [illegible] through its body.

—A ball bearing wheel is a [illegible] Frederick P. Vaughan, of Perry,

A BALL BEARING WHEEL

[illegible] wheel [illegible] of [illegible] outer ring.

Burglars' Tools.

[illegible] that [illegible] enterprising [illegible] way of devising more [illegible] safes. It seems that [illegible] caught in New York upon whose [illegible] lamp of the cylindrical type [illegible] York sensational journals a [illegible] use of the electric light instead [illegible] dark lantern. The London Daily [illegible] with avidity and enlarged upon [illegible] the following shape: "The [illegible] arrested two thieves who had [illegible]

[illegible] may be employed. It is absolutely desirable that the disturbances should be as powerful as possible and should be transmitted with a minimum loss. [illegible] both the intensity and the number [illegible] impulses and since the initial [illegible] there is necessarily limited only an instantaneous amount of energy is thus available for a single [illegible] the receiver. Further [illegible] through the cooperation of the [illegible] of an extremely rapid vibration [illegible] the operation of ordinary [illegible] these limitations of the two [illegible] reproduces arbitrarily [illegible] disturbances or effects [illegible] through the air to a distant [illegible] the energy derived from [illegible] the receiving station to charge [illegible] the accumulated potential [illegible] which [illegible] employed [illegible] station [illegible] of a storage device included in a circuit [illegible] connection points at a distance from the source of the disturbances and between which a difference of potential is created by such disturbances [illegible] the storage device [illegible] circuit, and a mechanism for closing [illegible] circuit at any desired moment, thereby [illegible] the receiver to be operated by the energy with which the storage device has been charged.

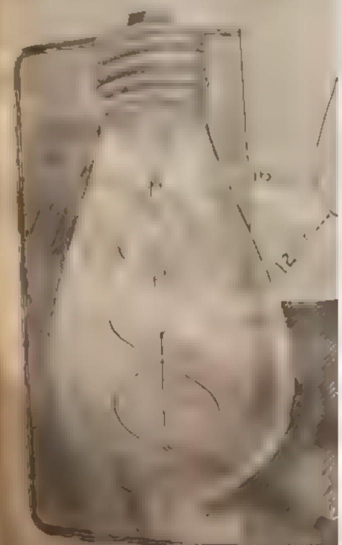
In another method the energy stored is not, as in the preceding instance, obtained from the energy of the [illegible] effect transmitted from a distance [illegible] an independent source. The method [illegible] consists in charging a storage device with energy from an independent source, controlling the charge of the device by the action of the effects or disturbances transmitted through the natural media [illegible] simultaneously using the stored energy for operating a receiver. A condenser is used as the storage means.

The invisible radiations of the spectrum and of vacuum tubes are generally considered to be vibrations of extremely small wave length. These radiations possess the property of charging and discharging conductors of electricity, the discharge being particularly noticeable when the conductor upon which the rays impinge is negatively electrified. It is usually held that these radiations ionize or render conducting the atmosphere through which they are propagated. Tesla's own experiments lead him however to conclusions more in accord with the theory [illegible] already advanced, in which he holds that [illegible] such radiant energy throw off with great [illegible] minute particles of matter which [illegible] strongly electrified and therefore capable of charging an [illegible] conductor or, even if not so, of discharging an electrified conductor either by carrying off bodily its charge or otherwise. Tesla has taken out a patent based upon a discovery which he has made that when rays or radiations of this kind are permitted to fall upon an insulated conducting body connected with one of the terminals of a condenser while the other terminal is made by independent means to receive or carry away electricity, a current flows into the condenser so long as the insulated body is exposed to the rays. Under certain conditions an indefinite ac[illegible]

[illegible] in the [illegible] having [illegible] of glowers of practical use, it is [illegible] conditions of practical adjustment of the ballast [illegible] additional adjustment [illegible] perfect working. It [illegible] to secure [illegible] to employ a ballast [illegible] made to employ, or so to construct the [illegible] chamber, or so to construct the [illegible] the ballast that it is not readily [illegible] Nernst has devised a divided ballast [illegible] which is standardized [illegible] perfectly [illegible] the remainder be adjusted according [illegible] conditions of each glower. By the [illegible] divided ballast it is possible to [illegible] in the standardized [illegible] or both.

[illegible] has likewise invented [illegible]

[illegible] to M. [illegible]



[illegible] IMPROVED FORM OF INCAND[illegible] MENT COMPARED WITH ONE [illegible] TYPE

[illegible] to any given voltage [illegible] section and composition [illegible] practice to make [illegible] given voltage [illegible] composition the same [illegible] Despite the [illegible] more or less [illegible] completed [illegible]

of electrical ... This energy a suitable time ... during which the ... allowed to act, may manifest itself in a powerful discharge which can be utilized for the operation of mechanical or electrical devices or ... useful in many other ways. The current is directed upon an elevated conductor, on ... with one of the armatures of the condenser ... electrified by the invisible radiation. The ... is carried off from the other armature by ... it with the ground. The accumulated effect ... discharged through a suitable receiver.

Recent Improvements in the Nernst Lamp.

Several patents have recently been issued in the United States to Walther Nernst, Henry N. Potter, and Marshall W. Hanks, for processes and devices designed to overcome various defects which have been found in the Nernst lamp.

Mr. Potter intends to use several spirals of wire to secure the heating of a single glower, or a number of glowers. A single spiral suffices to heat small glowers with sufficient uniformity, but when glowers of large candle capacity are to be started up, the heat must be more evenly distributed to prevent cracking of the glower. Instead of increasing the diameter and length of a small heater, which is rather costly, Mr. Potter finds it cheaper to multiply heaters in parallel ... heaters equal in surface to a single large ... The fins will heat up more quickly, as they ... a fraction of the mass of the large one. ... heaters can be so distributed about a glower ... their combined effects heat much more evenly ... single spiral practically can.

... quality possessed by the glowers of acquiring ... vessel conductivity under the influence of heat ... can be counterbalanced by the employment of ballast ... resistors placed in series with the glowers. ... the practical manufacture of standardized ballasted glowers having uniform qualities under the ... conditions of practical ... Mr. Potter sometimes found that ...

THREE NEW ELECTRIC

... the matter of ... lamp of ... the reason that ...

received several
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for a
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of electrical disturbances which
has its other terminal connected
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he operation of ordinary re-
ese limitations of the two
ble reproduces arbitrarily
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through the air to a distant
the energy derived from
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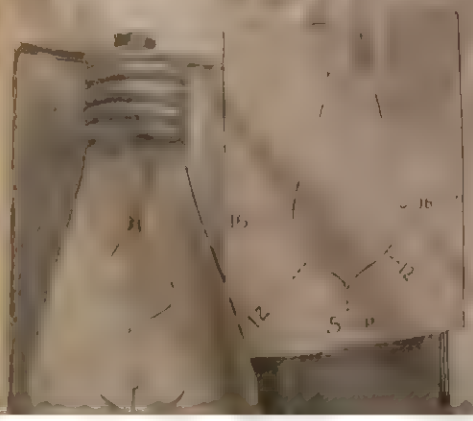
In the practical manufacture of standardized ballasts and of glowers having uniform qualities under the conditions of practical use, it is sometimes found that additional adjustment of the ballast is needed in order to secure perfect working. It is sometimes desirable to employ a ballast inclosed in a chamber, or so to control the heat of the ballast that it is not readily adjustable. Mr. Nernst has devised a divided ballast, a portion of which is standardized as perfectly as possible, while the remainder is adjusted according to the peculiar conditions of each glower. By the employment of the divided ballast it is possible to compensate for any [illegible] in the standardized ballast or in the glowers, both.

Mr. Nernst has likewise invented [illegible] compositions consist essentially of zirconia mixed with earths of the cerium group.

An effective and easily practiced method for treating Nernst lamp glowers whereby they may be connected to a circuit of a given voltage is the subject of a patent granted to Mr. Hanks. The adaptability



SPRING OUTER LAMP HANGER

SCIENTIFIC AMERICAN

L OF PRACTICAL INFORMATION

SEPTEMBER 30, 1911

... Stations, New York.

The Tesla Steam Turbine

The R... Heat Mot... Its Simplest Forms

It will interest the readers of the ... to know that Nikola Tesla ... must naturally stand upon the contributions he made to electrical engineering when the art was yet in its comparative infancy, is by training and choice a mechanical engineer with ...

... attention to improve ... and the result of his ... experiments is to be found in ... of prime movers shown in operation at ... station of the New York Edison Company ... placed the facilities of their great plant at ... carrying on experimental work ...

... the courtesy of ... through the accompanying ... plant at the Wat... of this ...

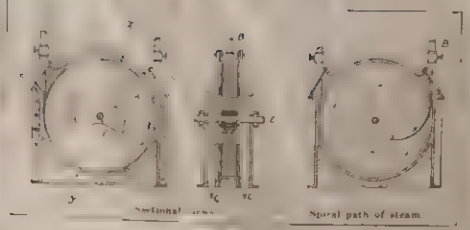
... which determined Tesla's inves... steam ... as a vehicle of energy ... can be obtained only ...

The turbine used as a pump

A 200 horse power high pressure turbine

... weighing less than ... total drop available. ... the mechanical standpoint ... simple and economical ... very nature of its construction, ... such a durability and freedom from wear and breakdown as to place it, in these respects, far in advance of any type of steam or gas motor of the present day.

Briefly stated, Tesla's steam motor consists of a set of ... disks mounted on a shaft and ...

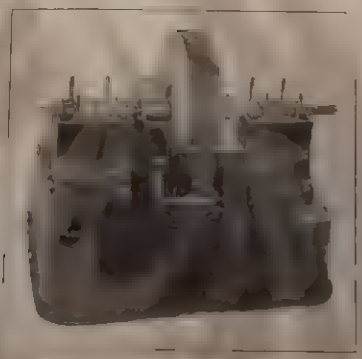


Sectional view — Spiral path of steam

Details of turbine

Some Striking Coal Facts

Foreign Students in America



Engine with upper half of casing removed

The Tesla turbine testing plant at the Edison Waterside Station, New York

The Tesla Steam Turbine

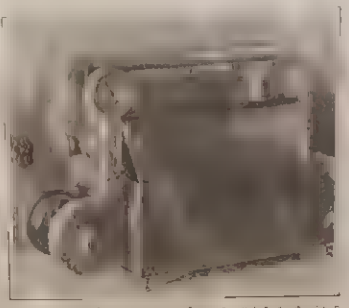
The Rotary Heat Motor Reduced to Its Simplest Terms

It will interest the readers of the SCIENTIFIC AMERICAN [illegible] outputs of 200 horse-power from a single-stage steam

The Tesla turbine testing plant at the Edison Waterside Station, New York.

The Tesla Steam Turbine

The Rotary Heat Motor Reduced to Its Simplest Terms



The turbine used as a pump

output of 200 horse-power from a single-stage steam turbine with atmospheric exhaust, weighing less than 2 pounds per horse-power, which is contained within a space measuring 2 feet by 3 feet, by 2 feet in height, and which accomplishes these results with a thermal fall of only 130 B.T.U., that is, about one-third of the total drop available. Furthermore, considered from the mechanical standpoint, the turbine is astonishingly simple and economical in construction and by the very nature of its construction, should prove to possess such a durability and freedom from wear and breakdown as to place it, in these respects, far in advance of any type of steam or gas motor of the present day.

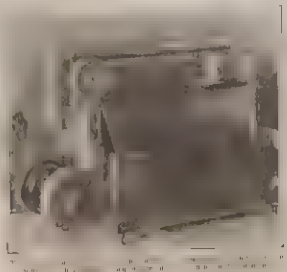
Briefly stated, Tesla's steam motor consists of a set of flat steel disks mounted on a shaft and rotating within a casing the steam entering with high velocity at the periphery of the disks, flowing between them in free spiral paths and finally escaping through exhaust ports at their center. Instead of developing the energy of the steam by pressure reaction or impact on a series of blades or vanes, Tesla depends upon the fluid properties of adhesion and viscosity, the attraction of the steam to the faces of the disks and the tenacity of its particles to cling to each other, in transmitting the velocity energy of the motive fluid to the disks and the shaft.

By reference to the accompanying photographs and drawings it will be seen that the turbine which in the present case consists of 25 flat steel disks one thirty-second of an inch in thickness, of hardened and carefully tempered steel. The disks, assembled [illegible] in diameter, are mounted on a shaft and when the turbine is running at its maximum working velocity the [illegible] are separated by a space of [illegible] of an inch. The [illegible] is mounted in a casing provided with two inlet nozzles for admitting the motive fluid, steam or gas. Outlets are provided at the central portion of the disks, and these connect directly with exhaust ports formed in the side of the casing.

In operation the steam or gas, as the case may be, admitted at the periphery of the disks through the nozzles which are so directed as to cause it to enter the casing in a straight or continuously curving path, gradually loses its expansive energy, is converted into velocity energy. When [illegible]

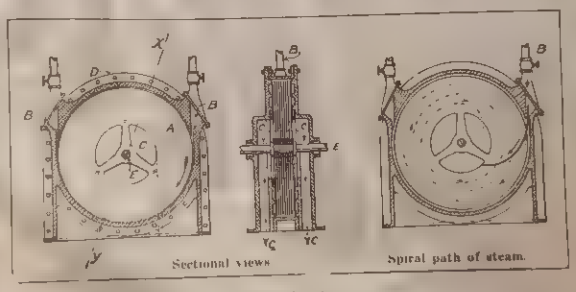
The Tesla Steam Turbine

The Rotary Heat Motor Reduced to Its Simplest Terms



The turbine used as a pump

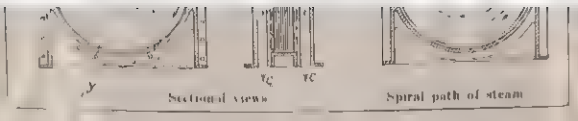
A 200 horse power high pressure turbine



Details of turbine.

Some Striking Coal Facts

LAST year the United States had [illegible] of 378 [illegible] with a production of 253,741,192 tons



Details of turbine.

bottom of

fashionable economical

mounted in a two-part

The fact that the place of the buckets

ordinary centrifugal pump

standard kind

horse power with 125 pounds at the supply

and free exhaust, it could show an output

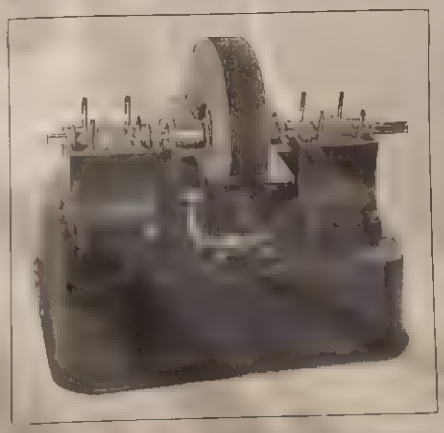
with the full pressure of

Furthermore, Mr

connection to

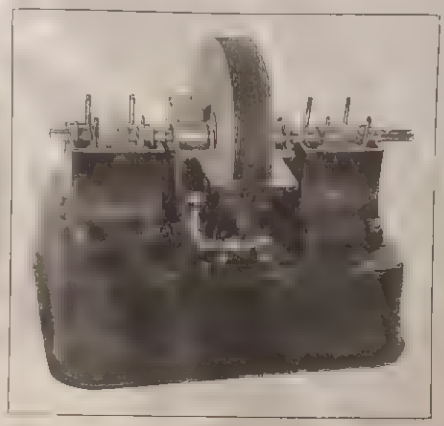
inches of vacuum

Some Striking Coal Facts



Turbine with upper half of casing removed.

Foreign Students in America



This turbine, whose rotor consists simply of a set of thin disks 8 inches in diameter, develops 200 brake horsepower at full

Turbine with upper half of casing removed

Foreign Students in America

The Tesla turbine testing plant at the Edison Waterside Station, New York.

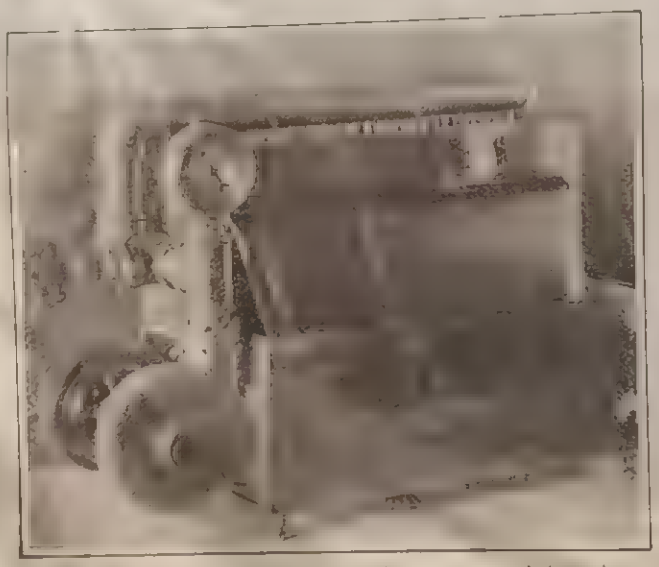
The Tesla Steam Turbine

(The Rotary Heat Motor Reduced to Its Simplest Terms

The Tesla turbine testing plant at the Edison Waterside Station, New York.

The Tesla Steam Turbine

The Rotary Heat Motor Reduced to Its Simplest Terms



This little pump, driven by a motor of ½ horse-power, is here shown delivering 40 gallons of water per minute against a 9 foot head.

The turbine used as a pump.

...e SCIENTIFIC AMERI-
...a, whose reputation
...ntributions he made
...e art was yet in its
...ng and choice a me-
...aning to that branch
...rm "steam engineer-
...has devoted much of
... thermo-dynamic con
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...et that when a fluid

output of 200 hors
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2 pounds per horse
a space measuring
and which accompl
fall of only 130 B.T
total drop availabl
the mechanical star
simple and econon
very nature of its
sess such a durab
breakdown as to
advance of any ty
present day.

Briefly stated, T
of flat steel disks
within a casing, th
at the periphery o
free spiral paths, a
ports at their cent
of the steam by
series of blades or

of their great plant at his disposal
rimental work.
f the inventor, we are enabled to
panying views, representing the
Waterside station, which are the
this interesting motor that have
.

e which determined Tesla's inves
ell-known fact that when a fluid
r) is used as a vehicle of energy,
economy can be obtained only
in velocity and direction of the
id are made as gradual and easy
present forms of turbines in which
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De Laval, Parsons, and Curtiss
sudden changes both of speed and
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eddies. Furthermore, the intro-
blades, buckets, and intercepting
eral class, into the path of the
delicate and difficult mechanical
adds greatly to the cost both of
ntenance.

an ideal turbine group themselves
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so controlled from the inlet to the
ergy was delivered to the driving
possible losses due to the mechan-
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which combined simplicity and
ction, durability, ease and rapidity
nall ratio of weight and space or
delivered on the shaft. Mr Tesla
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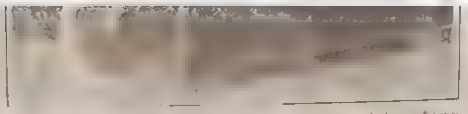
s carried the steam and gas motor
toward the maximum attainable
etical and mechanical. That these
ided is shown by the fact that in
Edison station, he is securing an



This horse-power, driven by a motor of ½ horse-power, is here shown delivering 40 gallons of water per minute against a 9-foot head.

The turbine used as a pump.

This view shows one complete high pressure unit, with the steam throttle above, and below it the reversing valve and the [illegible] turbine. Note the many gages used in t[illegible]

A 200-horse-power high-pressure turbine.

Briefly stated, Tesla's steam motor consist
of flat steel disks mounted on a shaft and
within a casing, the steam entering with hig
at the periphery of the disks, flowing betwee
free spiral paths, and finally escaping throug
ports at their center. Instead of developing
of the steam by pressure, reaction, or imp
series of blades or vanes, Tesla depends upo
properties of adhesion and viscosity—the att
the steam to the faces of the disks and the
of its particles to molecular separation con
transmitting the velocity energy of the moti
the plates and the shaft.

By reference to the accompanying photogr
line drawings, it will be seen that the turb
rotor *A* which in the present case consists
steel disks, one thirty-second of an inch in
of hardened and carefully tempered steel.
as assembled is 3½ inches wide on the fa
inches in diameter, and when the turbine i
at its maximum working velocity, the m
never under a tensile stress exceeding 50,0
per square inch. The rotor is mounted in
D, which is provided with two inlet n
for use in running direct and *B'* for reversir
ings *C* are cut out at the central portion of
and these communicate directly with exha
formed in the side of the casing

In operation the steam, or gas, as the cas
is directed on the periphery of the disks th
nozzle *B* (which may be diverging, straigh
verging), where more or less of its expansi
is converted into velocity energy. When the
s at rest the radial and tangential forces d
pressure and velocity of the steam cause it to
a rather short curved path toward the centra
opening, as indicated by the full black lin
accompanying diagram; but as the disks com
otate and their speed increases, the steam
spiral paths the length of which increases

ve speed, which is at
of the disks and is
of the steam. Hence
is very great, being
entrifugal force acting
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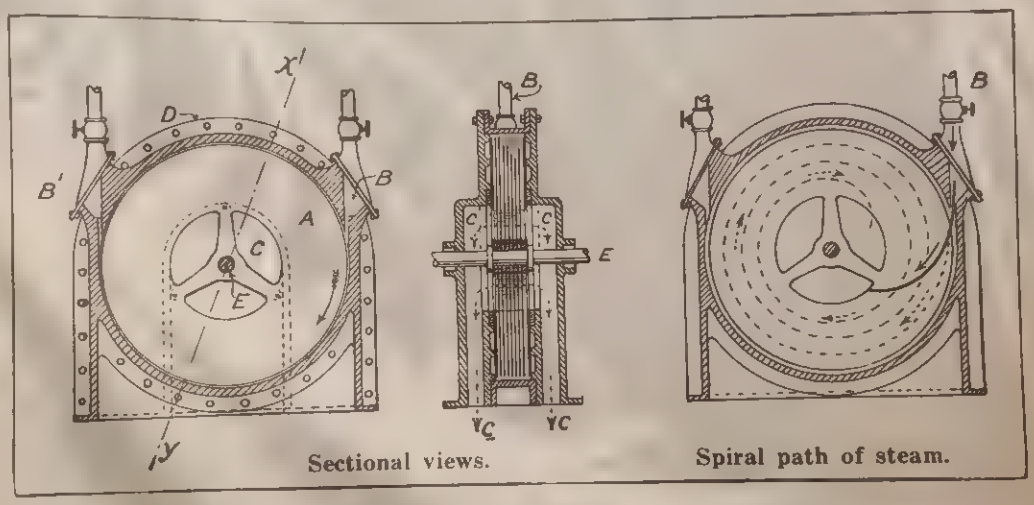
ow a baffle plate flows

mal efficiencies have been obtained which demonstrate that in large machines based on this principle, in which a very small slip can be secured, the steam consumption will be much lower and should, Mr Tesla states, approximate the theoretical minimum, thus resulting in nearly frictionless turbine transmitting almost the entire expansive energy of the steam to the shaft.



Sectional views. Spiral path of steam.

Details of turbine.

Some Striking Coal Facts

in 1900 it was 5½ to
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Fastened to the
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t lamp placed in-
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of the same, and
and lenses, they
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bine so that the
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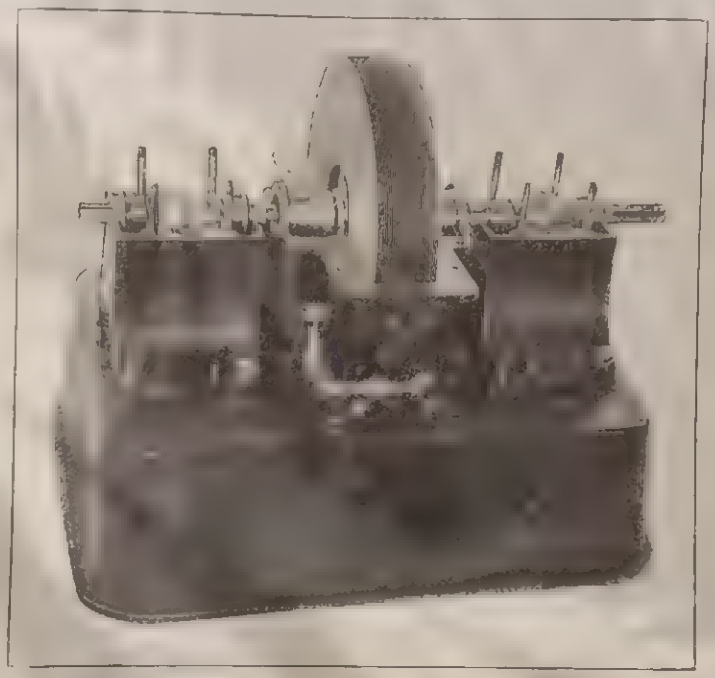
mirrors are so set that

The mere increase of the coal output of the United States for 1910 over that of 1909—40,781,762 tons—was greater than the total production of any foreign country except Great Britain, Germany, Austria, Hun-



This turbine, whose rotor consists simply of a set of flat disks 18 inches in diameter, develops 200 brake horse-power on test.

Turbine with upper half of casing removed.

Foreign Students

ADDRESSING the House o
many new activities of the
service, Representative
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made by our diplomat
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been fruitful of results

One of the outcomes
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preparatory department
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the number is steadily

Through the efforts
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These students are to b
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of the ambassador at Constan

Leland Irving Anderson

SCIENTIFIC AMERICAN

NEW YORK JUNE 4, 1904 5 CENTS A COPY $3.00 A YEAR.

Protected Cruiser "Tsushima"

Sinking of the Battleship "Hatsuse," Sunk by a Mine, With Loss of 450 Men

THE JAPANESE NAVAL DISASTERS (See page 4

SCIENTIFIC AMERICAN SUPPLEMENT

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Vol. LV. No. 1427. NEW YORK, JUNE 4, 1904. Scientific American Supplement.

...ublishers and compiler of bridges. Mr. ...nafalcon Bridges Fly, embodied who was ...ployed, as we also the cours Eng... ...k that time in Peat, and who was also ...presented doctor of the whole Engli... ...ciety could not speak highly enough ...emory of the Engl...h working class.

...he the Lancashi... was erected between 1840 and ...1849, and is still nowadays quite unequaled—it is ...unique of its kind, decorating its delightful city. The ...

...rest not me...

The rapid growth of population ... the government to the convention l... would not prove sufficient in regard to traffic ...

...om one town into the other. Thus ...e was made. However the trade and ...

THE ... BRIDGE AT SUDA ST...

[illegible] was the shortening to as [illegible] wagoning of the coal from the [illegible] rope. In conclusion he might [illegible] attained such definite objects [illegible] man employed [illegible]

FIG. 1.—TESLA EXPERIMENTAL LABORATORY IN COLORADO, ERECTED DURING THE SUMMER OF 1900

[illegible] by Mr. Tesla of the [illegible] in the earth was made here.

[illegible] which [illegible] able to a profit by [illegible] (3) more [illegible] ng, (4) better round coal [illegible] (5) greater area exposed [illegible] of four seams [illegible] It was [illegible] possible [illegible] better [illegible] before not [illegible] also to keep the machine [illegible] distinguished in his [illegible] mechanic and the electrician [illegible] and no doubt considered [illegible] work of a higher class, such as th[illegible] say 33 per [illegible] most laborious [illegible] others, the Hulton [illegible] return to [illegible]

THE TRANSMISSION OF [illegible] ENERGY WITHOUT WIRES.*

[illegible]

globe and studying its periodic and casual fluctuations. This formed part of a plan carefully mapped out in advance. A highly sensitive self-restorative device controlling a recording instrument was included in the secondary circuit, while the primary was connected to the ground and an elevated terminal of adjustable [illegible] The variations of potential gave rise to [illegible] in the primary, these generated [illegible] which in turn affected the sensitive [illegible] in proportion to their intensity. [illegible] was found to be, literally alive with [illegible] and soon I was deeply [illegible] in this interesting investigation. No better opportunities for such observations as I intended to make could be found anywhere. Colorado is a country famous for the natural displays of electric force. In that dry and rarefied atmosphere the sun's rays beat the objects [illegible]

of fire wit[illegible] balls [illegible] [illegible] expectation [illegible] dications again began [illegible] after passing [illegible] ce of [illegible] Nor did [illegible] [illegible] tien [illegible]

FIG. 2.—TESLA [illegible] POWER PLANT AND TRANSMITTING TOWER [illegible] WARDEN[illegible] N. Y.

[illegible]

with fierce intensity [illegible] [illegible]

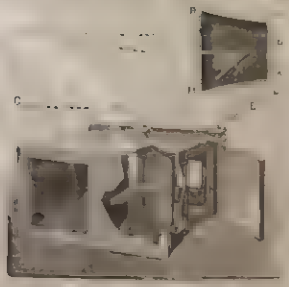

FIG. 2. THE ... AND ... APPARATUS AND ... FOR VIEWING STEREOSCOPIC ...

inclusion, he might safely claim that
d such definite objects as: (1) More
employed; (2) coal economically work-

controlling a recording instrument, wa
the secondary circuit, while the primary
to the ground and an elevated terminal

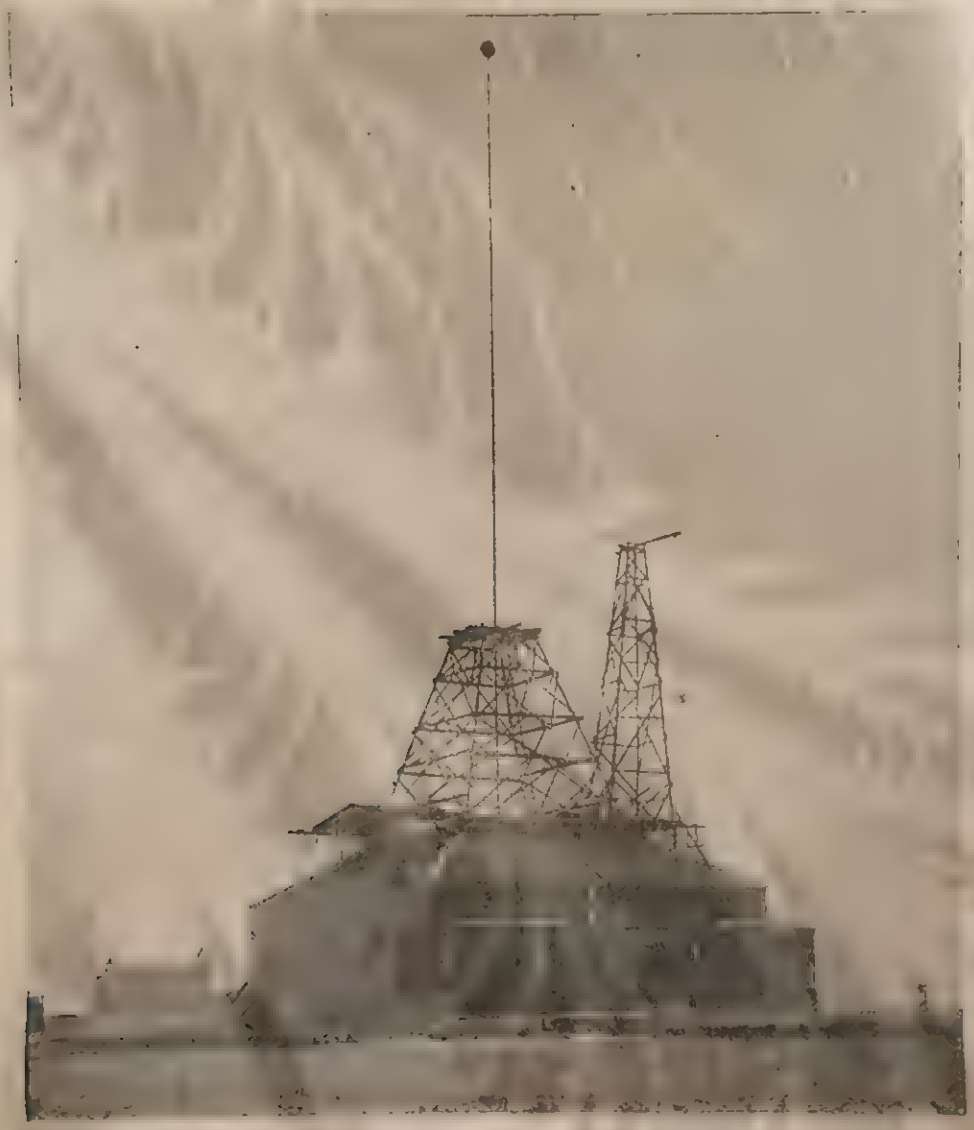

Fig. 1.—TESLA EXPERIMENTAL LABORATORY IN COLORADO, ERECTED DURING THE SUMMER OF 1899.

(The discovery by Mr. Tesla of the stationary waves in the earth was made here.)

busly had been unworkable to a profit
more systematic working; (4) better
three out of four mines; (5) greater
same time in two out of four seams;
er ton for risk of life reduced by one-
carcely possible to say how far the ef-

capacity. The variations of potential
electric surgings in the primary; th
secondary currents, which in turn affec
tive device and recorder in proportion t
ity. The earth was found to be, litera
electrical vibrations, and soon I was de

re. Colorado is a country famous for lays of electric force. In that dry osphere the sun's rays beat the objects

treated to a distance of about three hun
ters (156 [illegible]). Nor did these strange ac
then, but continued to manifest themselves

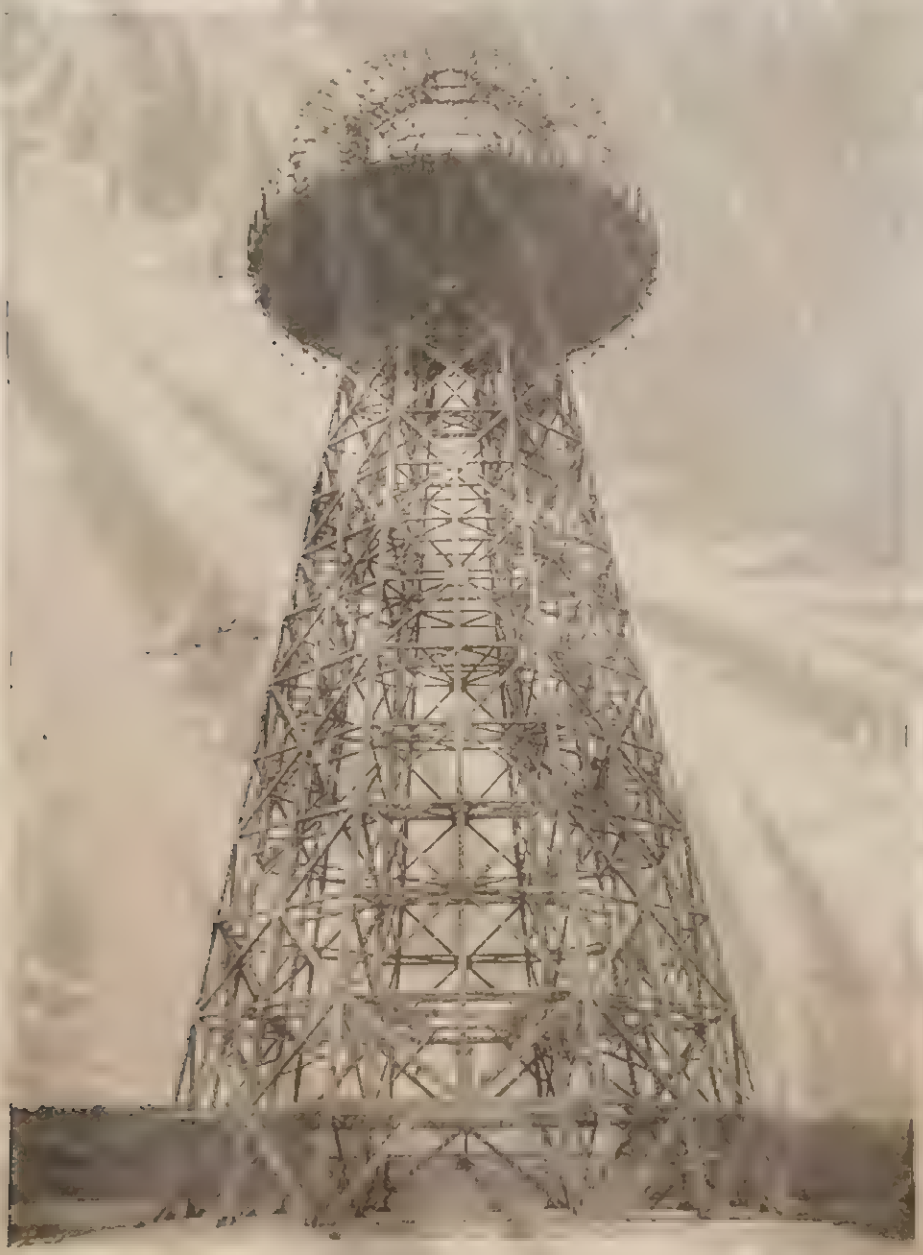

FIG. 2.—TESLA CENTRAL POWER PLANT AND TRANSMITTING TOWER FOR WORLD TELEGRAPHY, AT WARDENCLYFFE, LONG ISLAND, N. Y.

(The tower is a pyramid having eight sides; smallest dimensions across base, 95 feet; height, 154 feet; total height from ground to top, 187 feet; cupola on top, 65.62 feet in diameter.)

FIG. 1. [illegible] EXPERIMENTAL AVIATORY IN COLORADO [illegible]

[illegible] ENERGY

Towards the close of [illegible] a systematic research car[illegible]

FIG. 3. TESLA CENTRAL POWER PLANT AND TRANSMITTING TOWER FOR WORLD TELEGRAPHY AT WARDENCLIFFE, LONG ISLAND, N. Y.

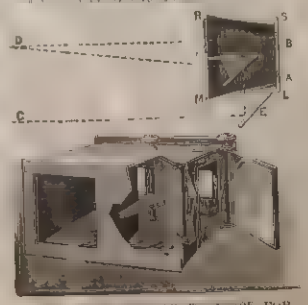

FIG. 1.—BELLENIS APPARATUS FOR OBSERVATION OF STEREOSCOPIC PROJECTIONS.

STEREOSCOPIC PROJECTIONS

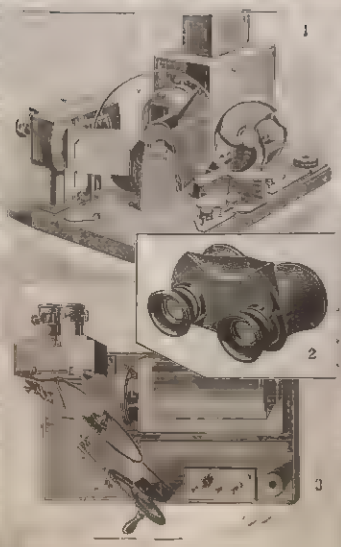

FIG. 2.—THE SCHMIDT AND DEITZ APPARATUS AND OPERA GLASS FOR OBSERVING STEREOSCOPIC PROJECTIONS

SCIENTIFIC AMERICAN

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...RST YEAR

SCIENTIFIC AMERICAN

...LY JOURNAL OF PRACTICAL INFORMATION

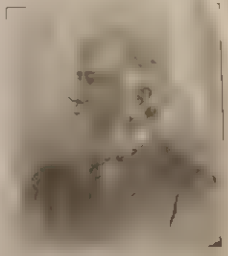
NEW YORK. JUNE 5, 1915

...PY
...A YEAR

Gordon McKay, inventor of the McKa... shoe making machines.

Isaac Singer, inventor of the Singer sewing machine

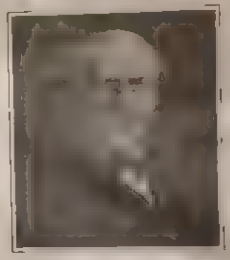
Lyman E. Blake, inventor of shoe-making machinery



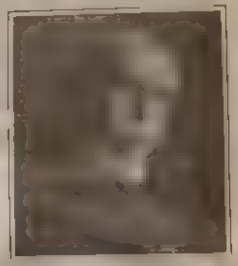
Charles Goodyear, inventor of the Goodyear lasting machinery

Joseph Henry, who laid the foundation of the electric telegraph.

Charles J. Vandepoele, inventor of American overhead trolley system.

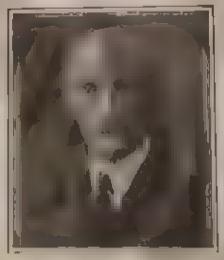


Dr Coleman Sellers, pioneer motion picture and machine tool inventor.



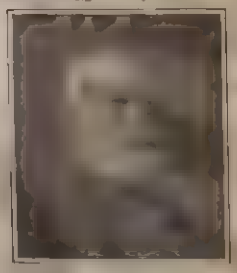
Count von Zeppelin, inventor of the rigid airship.

Prof. J. A. Fleming, inventor of the electric valve used in wireless.



James Gayley, inventor of the dry-blast process of steel making

Charles E. Scribner, inventor of telephone switchboards



J. S. Hyatt, an industrial chemist, who discovered celluloid

...Sprague, inventor of the multiple unit system of train control.

Charles G. Curtis, inventor of the Curtis steam turbine

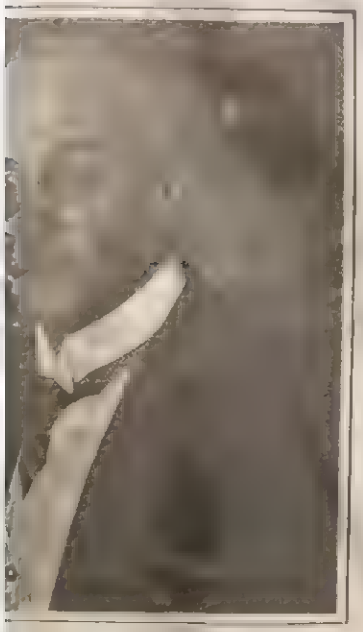
Dr. Rudolf Diesel, inventor of the Diesel engine

Charles P... inventor of the ...

SOME GREAT INVENTORS OF THE PAST SEVEN DECADES

Scribner, inventor of tele-
ne switchboards.

J. S. Hyatt, an industrial chemist, who discovered celluloid.

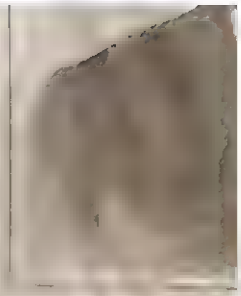


Levick
Diesel, inventor of the
Diesel engine.

Charles P. Steinmetz, inventor of the magnetite arc.

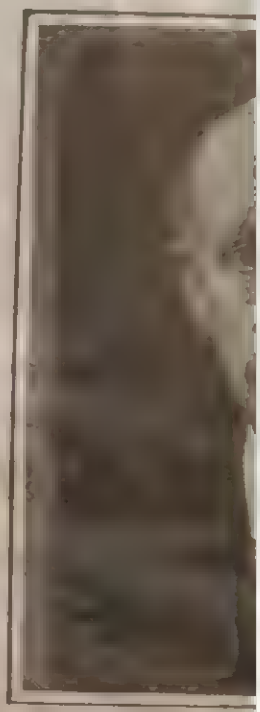
SEVEN DECADES

Joseph Henry, who laid the foundation of the electric telegraph.

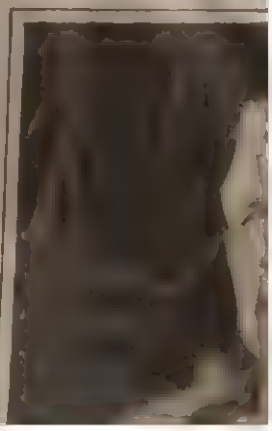


Charles J. Va
American ove

Prof. J. A. Fleming, inventor of the electric valve used in wireless.



James Gayley,
blast process



Some of Edison's work in the decade 1875-1885.

In the same year Pelton, an American, invented the Pelton wheel, in which cups are used instead of blades, the cups being so designed that they utilize the force of the impinging water to the utmost.

Mergenthaler and His Linotype.

For many decades inventors had endeavored to supply a satisfactory machine which would rapidly set type and which would enable newspaper proprietors to turn out papers more rapidly than was possible with hand composition. It was not until 1888 that such a machine was invented. It was the invention of Ottmar Mergenthaler, and it worked on an entirely new principle. Instead of seeking to set the types and after their use to distribute them among their respective receptacles in order that they might be automatically composed the principle on which previous inventors had worked Mergenthaler composed the type-matrices, and from these cast, as a single piece, a line of characters. Hence, his machine was called a "linotype." Mergenthaler's matrix was of brass, flat and rectangular, having a V-shaped notch cut deep into its upper end, the edges of the notch being lined with small hook like projections

frame properly and set the mold needed, while the pump and co-operi cast the character and place it in it a tray, or "galley," at the rate o minute.

The Invention of the Au

The first really successful moder bon automobile appeared in 1883. built by Gottlieb Daimler. His su been due very largely to his autom

George Westinghouse, whose invention of the air-brake made modern high-speed railway travel possible.

the original machine itself being still used in electric testing. It is described in patent 432,655 of July 22nd, 1890.

An important invention bearing on interpole work, now such a decided factor in the construction of dynamos and motors for continuous currents is shown in patent 459,422, filed in 1885 and issued September 15th, 1891. This dynamo appears to be a pioneer invention in that the separation of the series and shunt coils on the field for securing better commutation and at the same time compounding a machine, are found. The

that the effect
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vaal took up
introduced.

The first co
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John B. Dun
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Sir William Thomson (later Lord Kelvin) inventor of the siphon recorder.

at each end, or eight in all. Aside from other material advantages it is estimated that at least from $15,000,000 to $20,000,000 has been saved by the Edison quadruplex, merely in the cost of line construction in America.

Another system of multiple transmission was proposed by Moses G. Farmer of Salem, Mass., in 1852, in which by a commutating arrangement the main line was put in rapid succession in contact with a series of branch wires by proper

Copyright Harris & Ewing

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Copyrighted by Brown Bros.

Prof. Michael I. Pupin, inventor of the load coil that made transcontinental telephoning possible.

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Marconi and one of his early wireless sets.


SCIENTIFIC AMERICAN
Alexander Graham Bell.
Emile Berliner.

THE ELECTRICAL WORLD.

Phenomena of Alternating Currents of Very High Frequency.

BY NIKOLA TESLA

ALTERNATE CURRENT MACHINES OF HIGH FREQUENCY; CURRENTS IN ELEMENTS WITH GEISSLER TUBES AND LAMPS; AN INDUCTION MOTOR WITHOUT ALTERNATING ARCS; CONSTANT CURRENT AND CONSTANT POTENTIAL INTERRUPTER; EXPERIMENT WITH A CONDENSER; THE FERRANTI MAIN EFFECT; DATA, TIME BASE DU PELLETIER REGRADER; SUGGESTION OF MR. SWINBURNE.

Electrical pursuits is getting to be more and more interesting. New facts are observed and new problems spring up daily which emanate the attention of engineers. In the last few numbers of the English journals principally in the *Electrician*, there have been several new matters brought which have attracted more than usual attention. The address of Professor Crookes has revived the interest in his beautiful and skillfully performed experiments; the effect observed on the Ferranti mains has elicited the expressions of opinion of some of the leading English electricians and Mr. Swinburne has brought out some interesting points in connection with condensers and dynamo excitation.

The writer's own experiments have induced him to venture a few remarks in regard to these and other matters, hoping that they will afford some useful information or suggestion to the reader.

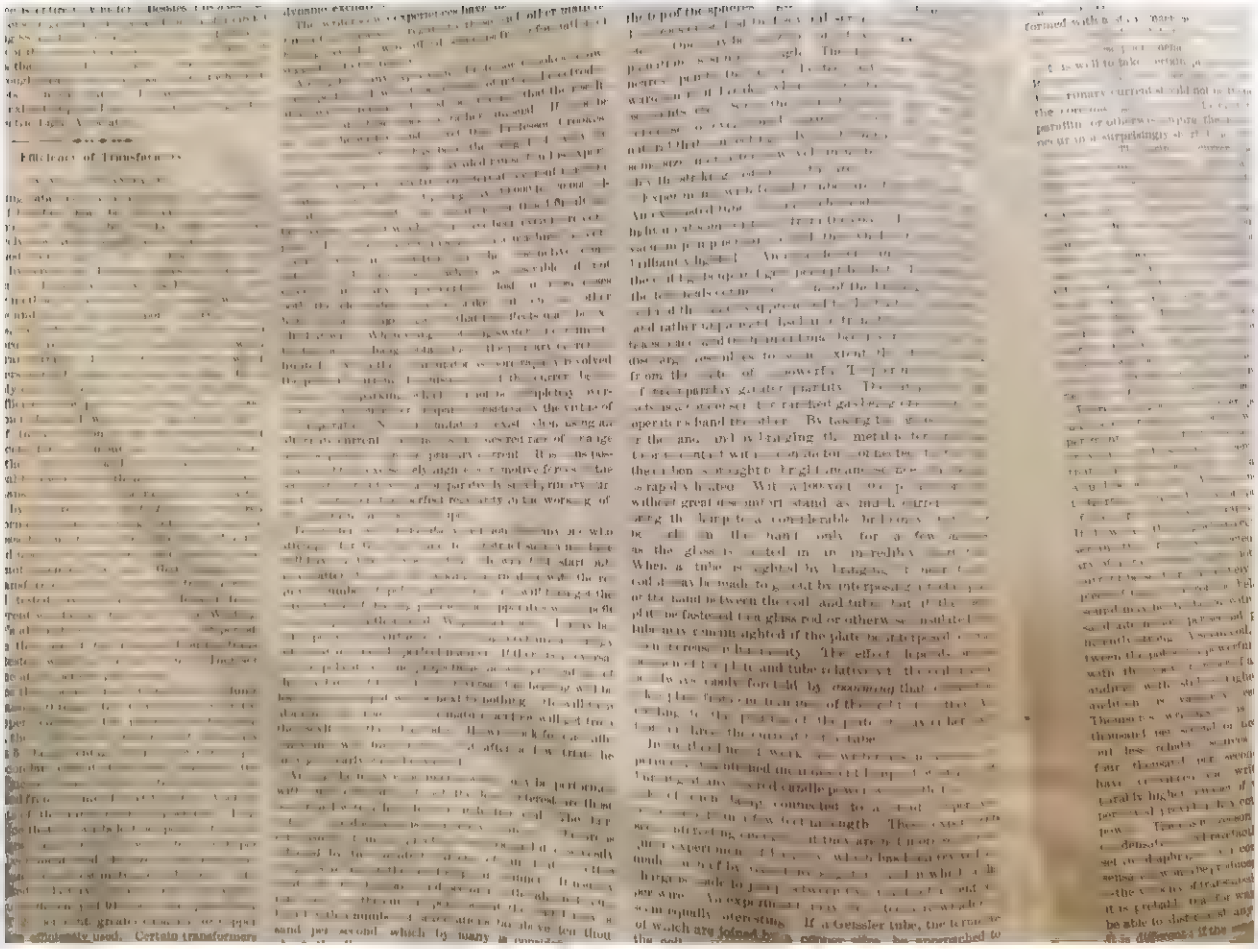
Among many experiments Professor Crookes showed some performed with tubes devoid of internal electrodes and first described and must be inferred that the results obtained with these tubes are rather curious. If this be so, then we must regret that Professor Crookes with a view to work out has been the delight of every investigator. Had he availed himself of his experiments of properly constructed alternate current machine, namely one capable of giving, say, 10,000 to 20,000 alternations per second. The researches of this often that fascinating subject would then have been even more complete. It is true that while using such a machine in connection with an induction coil the distinctive characteristics of the electrodes would be lost, which if not both the electrodes being alike, in most cases would be an advantage is gained that the effects may be exactly the same. When using a rotating switch or commutator for the rate of change obtainable in

the writer, the discharge of even
produce seriously injurious
coil were operated with
though the electromotive
the discharge would be
sult, however, is due in part to
writer's experiences tend to show
quency the greater the amount
may be passed through the
comfort; whence it seems certain that
condensers.

One is not quite prepared for the
when connected to a Leyden jar
cipates that since the frequency is high
jar should be small. He therefore
about the size of a small wine glass
with this jar the coil is practically
then reduces the capacity until he
capacity of two spheres, say, ten centimetres
and two to four centimetres apart. The
assumes the form of a serrated
like a succession of sparks viewed
revolving mirror; the serations, of course
to the condenser discharges. In this case
serve a queer phenomenon. The discharge start
nearest points, works gradually up
the top of the spheres, begins again at the bottom
This goes on so fast that several serrated bands
once. One may be puzzled for a few minutes
planation is simple enough. The discharge
nearest points, the air is heated and carries
ward until it breaks when it is reestablished
est points etc. Since the current passes
condenser of even small capacity, it will be
natural that connecting only one terminal
some size, no matter how with a small
ably the striking distance of the air.

Experiments with Geissler tubes are of special
An exhausted tube devoid of electrodes
ught up at some distance from the coil. If
vacuum pump
brilliantly
the coil lights up
the terminals connected to one of the binding
coil and the

or less parallel with that
the brilliancy of the
Numerous other phenomena
assumption. For instance
vided with wires of
plating the terminals
is then nearly the
otherwise
the wash
tube be inclined
in spite of the



Phenomena of Alternating Currents of Very High Frequency.

... current machine ... 1,000 to 20,000 alternations ... His researches on this difficult but fascinating subject would then have been even more complete. It is true that when using such a machine in connection with an induction coil the distinctive character of the electrodes—which is desirable if not ... in many experiments ... lost in most cases ... the electrodes behaving alike, but, on the other hand ... it might be argued that the effects may be exhibited with ... switch or commutator ... the primary current diminishes ... the sparking, which ... No such limitations exist when using an alternate current ... It is thus possible ...

... natural that connecting only one terminal to a body of some size, no matter how well insulated, impairs considerably the striking distance of the arc.

Experiments with Geissler tubes are of special interest. An exhausted tube, devoid of electrodes of any kind, will light up at some distance from the coil. If a tube from a vacuum pump is near the coil ...

... of incomparably greater quantity ... acts as a condenser, the rarefied gas ... operator's hand the other ... in the hand, and by bringing ...

Efficiency of Transformers.

BY WILLIAM STANLEY, JR.

... vacuum pump is ignited ... touched with a wire connected ... current should be left on ... the glass will be cracked by ...

counteracted the self-induction with the existing frequency. If the capacity was increased or diminished the electromotive force fell as expected.

With frequencies as high as the above mentioned the condenser effects are of enormous importance. The condenser becomes a highly efficient apparatus capable of transferring [illegible] able energy.

The writer has thought that machines of high frequencies may find use at least in cases [illegible] great distances [illegible]

[illegible] In the lecture [illegible] he must content himself [illegible] words the process which in his opinion, must occur. [illegible] brings about two of [illegible] It changes the phases of the currents in the [illegible] it changes the strength of the currents. As [illegible] change in phase, the effect of the condenser is [illegible] rent in the secondary at Deptford and [illegible] mary at London. The former has [illegible] force on the [illegible] primary at London as [illegible] concerned has little or no effect [illegible] in the secondary in London.

[illegible] necessary [illegible] in order to see the importance of the Deptford step-up transformer that an increase of the current in both the branches produces opposite effects. At Deptford it means further [illegible]

[illegible] Two years later Mr Swinburne [illegible]

[illegible] armature reaction theory as expressed in *Industries* though undoubtedly there is some truth in it. Mr Swinburne's interpretation however is so broad that it may mean anything.

Mr Swinburne seems to have been the first who has called attention to the heating of the condensers. The astonishment expressed at that by the ablest electrician is a striking illustration of the desirability to execute experiments on a large scale. To the scientific investigator who deals with the minutest quantities, who observes the faintest effects, far more credit is due than to one who experiments with apparatus on an industrial scale and indeed history of science has recorded examples of marvelous skill, patience and keenness of observation. But however great the skill, and however keen the observer's perception, it can only be of advantage to magnify an effect and thus facilitate its study. Had Faraday carried out but one of his experiments on dynamic induction on a large scale it would have resulted in an incalculable benefit.

In the opinion of the writer, the heating of the condensers is due to three distinct causes: first, leakage or conduction, second, imperfect elasticity in the dielectric, and third [illegible]

[illegible] has been [illegible] For instance [illegible] candescent lamps the ends of the filaments being completely sealed in glass but attached to interior condenser [illegible] no more than a few centimetres square. Such lamps would be a practical success with sufficiently high frequencies. With alternations as high as 15,000 per second it was easy to bring the filaments [illegible] found that the [illegible] the higher the frequency [illegible] the lamp can

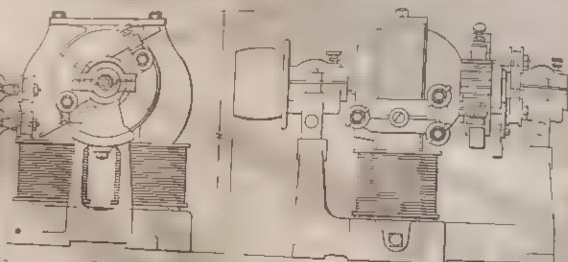
withstand. Such a [illegible] the dielectric always takes place when the amount of energy transferred across a dielectric of definite dimensions and by a given frequency is too great. Glass withstands best, but even glass is deteriorated. In this case the potential difference on the plates is of course too great and losses by conduction and [illegible] If it is desirable to produce con- [illegible] potential then [illegible]

[illegible]	Weight	[illegible]	[illegible]	[illegible]	Length	Breadth	Height	[illegible] bolt holes in base
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

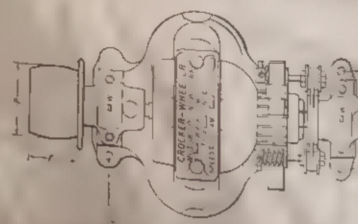
NOTE. The standard [illegible] stamped on before shipment but should the voltage of the [illegible] the speed of the motor. Also motors are wound for 6 & 8.5 and 15 ampere [illegible]

the only dielectric which will involve no losses is a gas under [illegible] pressure. The writer has worked with air under enorm[illegible] in that direction. He thinks that in order to make the condensers of considerable practical utility higher frequencies should be used though such a plan has besides others the great disadvantage that the system would become very unfit for the operation of motors.

If the writer does not err Mr Swinburne has suggested [illegible]



For a number of years past the writer has carried on experiments with the object in view of producing a practical self-exciting alternator. He has in a variety of ways succeeded in producing some excitation of the magnets by means of alternating currents, which were not commutated by mechanical [illegible] [illegible] currents displaced by a [illegible] may be produced [illegible] future time.



DIMENSIONS OF CROCKER-WHEELER MOTORS

The Dimensions of Crocker[illegible]

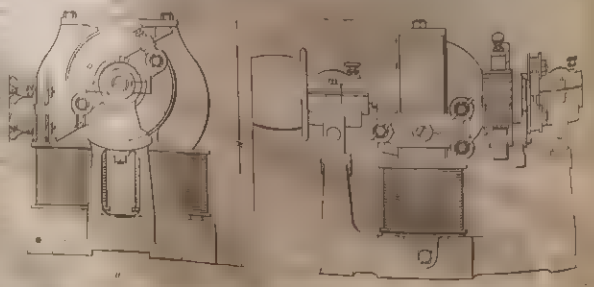
The space occupied by the [illegible] than that required for a stat[illegible] capacity that a great adva[illegible] motor in all locations wh[illegible] ance. As a means of [illegible] gines which any of our [illegible]

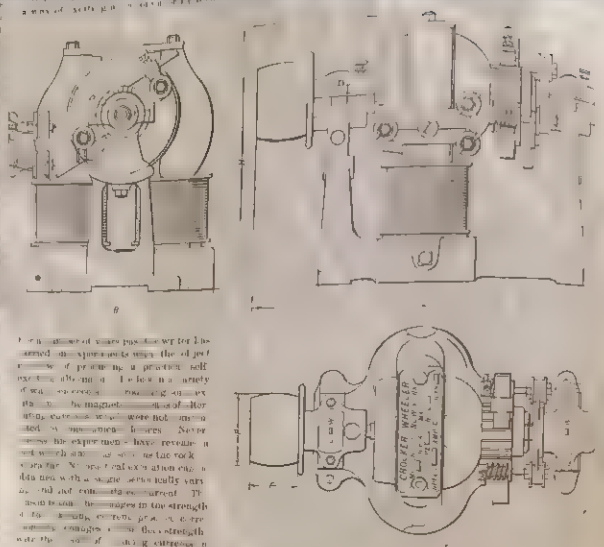
of one of the standard types of electric motors the [illegible] dimensions and other data and the diagramatic [illegible] ence to the [illegible] it will be seen that the [illegible] dimensions of a motor of any given capacity are [illegible] obtainable. The floor space and weight per horse[illegible] will always be found to be very much [illegible] of the electric motor as against the engine and boiler or even the engine alone. It must, however, be remembered [illegible]

that [illegible] against the wall.

Electric Lighting in the Elgin Watch Factory

The adaptability of the incandescent [illegible] This has [illegible] National Watch Company at Elgin [illegible] proportions which entitle [illegible] classed among the largest and finest of its kind in [illegible]





DIMENSIONS OF CROCKER WHEELER MOTORS.

Electric Lighting in the Elgin Watch Factory

[illegible] length of [illegible] may [illegible]

5. That the value of the standard of resistance constructed by a committee of the British Association for the [illegible] science in the years 1863 and 1864 and known as the British Association unit, may be taken as .9866 of the ohm.

6. That a material standard constructed in solid metal, and verified by comparison with the British Association [illegible]

[illegible]

[illegible] value one-tenth (0.1) in terms of the centimetre, gramme and second.

9. That an unvarying current which, when passed through a solution of nitrate of silver and water containing from 15 to 20 parts by weight of nitrate of silver in 100 parts of water, deposits silver at the rate of 0.001118 of a gramme per second, may be taken as a current of one ampere.

[illegible] time average of [illegible]

11. That an instrument constructed on the principle of the balance, in which by the proper disposition of the conductors forces of attraction and repulsion are produced which depend upon the amount of current passing [illegible] by a known weight, should be adopted [illegible] standard for the measurement [illegible]

12. The [illegible] standard of electrical pressure [illegible] being the pressure which, [illegible] conductor whose resistance is one ohm, will [illegible]

[illegible] pressure at a temperature of 62 [illegible] or electrodes of the voltaic [illegible] used in accordance [illegible]

[illegible] ated to a 60 h. p. engine. But [illegible] of its operations the needs of [illegible] timber line had so greatly reduced the [illegible] formerly grew in abundance a few [illegible] that the question of motive power became a serious one. On consideration it was seen that some system of electrical [illegible] should be employed, so that [illegible] in the immediate neighborhood [illegible]

FIG. 2. ARMATURE OF WESTINGHOUSE MOTOR AND GENERATOR.

The Gold King Mill is at an elevation of 11,000 feet above the sea, and 3,000 feet above the San Miguel Valley. The south fork of the San Miguel River in its descent from Ophir, a mining camp near Telluride, falls [illegible] feet in a distance of less than a mile. The river is fed almost entirely from springs in the Ophir basin, and even at the season of lowest supply can furnish about 2,000 h. p. Here was available power enough to operate every mine in the vicinity [illegible] an almost perfect natural site above the beginning of the rapid descent of the stream, and from the headgate the water is conducted through an iron pipe 4,000 feet long, at the beginning some 20 inches in diameter and then gradually decreasing to 12, along the valley to the power station. Here the stream is divided and the water is delivered to two six foot Pelton water wheels in the generating station itself. The ultimate capacity of 800 h. p. in [illegible]

[illegible] The loss in transmission is barely [illegible] The motor being of the synchronizing type [illegible] starting it very naturally arises. This [illegible] been the most serious difficulty with alternating [illegible] for the transmission of power. In this case the motor [illegible] was easy, for while used for the purposes [illegible] the motor does not have to be started at all frequently. Once in step with the generator it may run many hours without being stopped for any reason whatever. The starting device employed is a two-wire alternating motor of the Tesla form of construction of about 10 h. p. capacity; this machine is shown in Fig. 3. It is used simply and solely for bringing the large motor up to synchronism when it is cut out until again required. The large motor is self-exciting and takes care of [illegible] easily enough after it is once [illegible] up to speed. The Telluride plant promises to be, when it shall finally be put into operation a few weeks hence, one of the most interesting mining plants in the world from the nature of its location, which made electrical power a necessity, and especially from the daring way in which the difficulty of using very high potential has been met by employing a synchronizing motor. It is altogether probable that other mines in the vicinity will shortly receive a similar equipment, as the region is one where fuel is none too easily obtained and water power can be had almost for the asking. The plant is now rapidly nearing completion, and ere long we may hope to chronicle the starting of an installation that is unique in the electrical transmission of power among motor plants, and that has every reason to meet with most gratifying success.

Phenomena of Alternating Currents of Very High Frequency.

[illegible] March [illegible]

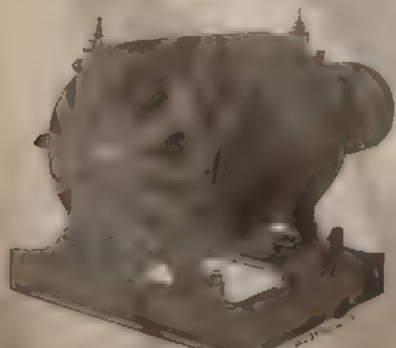


FIG. 3. TESLA MOTOR USED IN THE TELLURIDE PLANT.

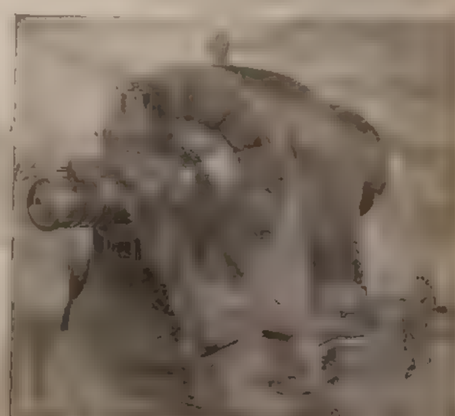


FIG. 1. MOTOR AND GENERATOR OF THE TELLURIDE MINING PLANT.

[illegible]

An Electric Mining Plant.

[illegible] Colorado [illegible] Valley [illegible]

[illegible]

[illegible] stout post at a sufficient distance above [illegible] to prevent anything [illegible]

[illegible]

pere, whether the current be unvarying or alternating.

12. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampère.

13. That the electrical pressure at a temperature of 62 degrees F. between the poles or electrodes of the voltaic cell, known as Clark's cell, constructed and used in accordance with the specification attached to these proceedings, may be taken as not differing by more than ..... parts in one thousand from a pressure of..... volts.

FIG. 3.—TESLA MOTOR USED IN THE TELLURIDE PLANT.

An Unique Mining Plant.

gradually decreasing to
station. Here the strea
cred to two six foot
Pelton water
wheels in the gener-
ating station itself.
The ultimate ca-
pacity of 800 h.p. in

the generators is provid
single 100 h. p. m
motor station is t
the generators. It was
plant synchronous alter
the potentials required

curing Company to supply the dam has been erected at what is site above the beginning of the eam, and from the headgate the h an iron pipe 4,000 feet long. 20 inches in diameter, and then along the valley to the power is divided, and the water is deliv-

Phenomena of Alternating Currents of Very High Frequency.

BY NIKOLA TESLA.

In the issue of THE ELECTRICAL WORLD of March 14 I find a note of Prof. Elihu Thomson relating to some of my

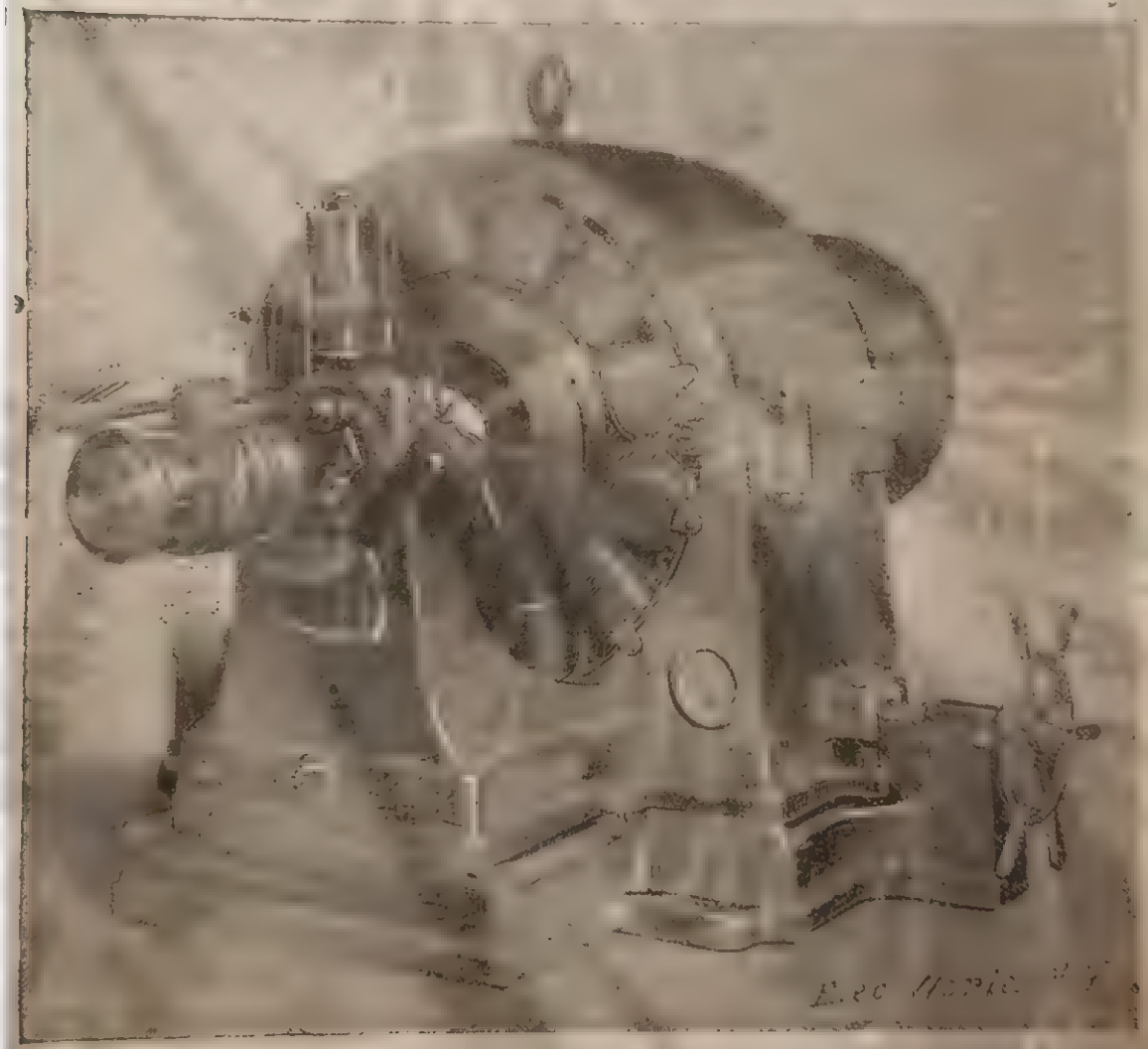


FIG. 1.—MOTOR AND GENERATOR OF THE TELLURIDE MINING PLANT.

for, although at present only a bine will be installed. The

experiments with alternating currents of very high fre quency which have been described in THE ELECTRICAL

2,000 h. p. Here
ery mine in the
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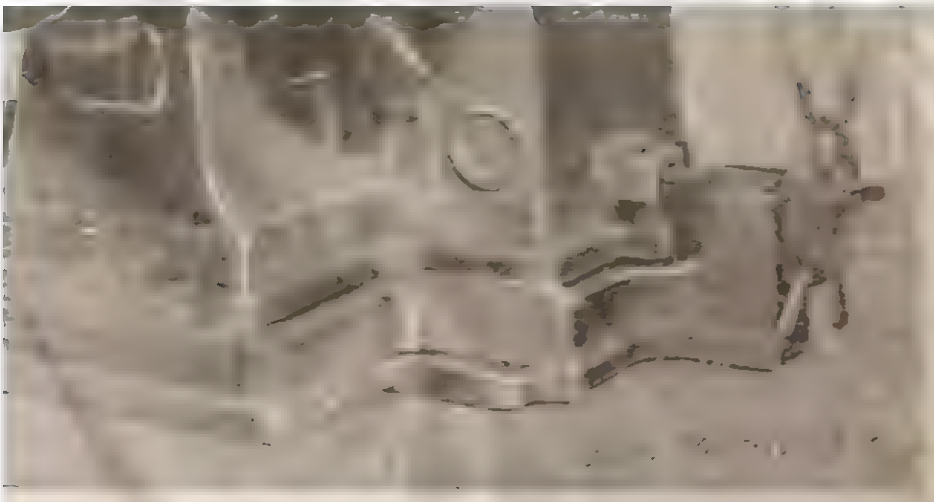

OR AND GENERATOR OF THE TELLURIDE MINING PLANT.

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experiments with alternating currents of very high fre- [illegible] have been described in THE ELECTRICAL [illegible] Feb. 21, 1891.

Prof. Thomson calls attention to the interesting fact that he has performed some experiments in the same line. I was not quite unprepared to hear this, as a letter from him appeared in *The Electrician* (London) a few months ago in which he mentioned a small alternate current machine which was capable of giving, I believe, 5,000 alternations per second, from which letter it likewise appears that his investigations on that subject are of a more recent date.

Prof. Thomson describes an experiment with a bulb inclosing a carbon filament which was brought to incandescence by the bombardment of the molecules of the residual gas when the bulb was immersed in water rendered slightly conducting by salt dissolved therein (?) and a potential of 1,000 volts, alternating 5,000 times a second, applied to the carbon strip. Similar experiments have, of course, been performed by many experimenters, the only distinctive feature in Prof. Thomson's experiment being the comparatively high rate of alternation. These experiments can also

[illegible]

heating of the gl[illegible]

[illegible] it is an undeniable fact that the [illegible] interesting feature in my experiment was that a lamp would light up when brought near to an induction coil and that it could be held in the hand and the filament be [illegible] incandescence.

[illegible]

[illegible] which was observed with an incandescent lamp. If a lamp be immersed in water as far as possible and the filament and the vessel connected to terminals of an induction coil operated from a machine such as I have used in my experiments, one may see the thin red filament surrounded by a very luminous glow around which there is a less luminous space. The effect [illegible]

[illegible]

number could be [illegible] could be produced with sufficient power. My statement is only speculative, but I have devised means which I think will allow me to [illegible]

[illegible]

Prof. Thomson states that I am tak[illegible]

[illegible] above could be inferred that Prof. Thomson has perhaps not thought that there are two [illegible] for each complete current wave, the [illegible] the direction of the current [illegible] learn that Prof. Thomson agrees with me [illegible]

[illegible]

[illegible] ler arcs are practicable.

[illegible] tation by Prof. Thomson of my statements [illegible] the reader will pardon me for [illegible]

[illegible] feel confident of the [illegible] views expressed [illegible]

[illegible] possible for any type [illegible] the different conditions [illegible]

In one case when the [illegible] able to employ the most effi[illegible] internal resistance in another case [illegible] not be the best to employ. It will certainly be admitted [illegible] to supply inca[illegible] lights are operated [illegible] is employed

in which the [illegible] which has no further influence upon the feed [illegible] feeding being effected by an independent mechanism, but even in this case the resistance must be considerably greater to allow a steady current. Now if the machine be such as to [illegible] there is no way of attaining the des[illegible] either made or [illegible]

[illegible] internal resistance [illegible] could be desirable. Now [illegible]

[illegible] may be made, [illegible]

[illegible]

As regards the better [illegible] lamps to the complete satisfaction [illegible] lamp in which an [illegible] the feed and the release [illegible]

[illegible] feed is affected [illegible]

[illegible]

[illegible] started this [illegible] my first company [illegible] was the first [illegible] It was not until [illegible] that on receiving [illegible] I learned [illegible]

[illegible] but I recognized [illegible]

[illegible] that he has run with perfect [illegible] circuit with coils of such large [illegible]

[illegible] wiped out." Surely Prof. Thomson does not mean to say that self-induction wiped out the [illegible] of the current. For this just the opposite [illegible] capacity is required. The self-induction of the coils in this case simply increased the impedance and variations occurring at large time intervals, which take place when the resistance in circuit with the lamps is too small or even with larger resistance in circuit when the [illegible]

Prof. Thomson further states that, in a lamp in which the feed mechanism is under the control of the derived circuit magnet only, the fluctuations pass through the [illegible]

[illegible] to dampen the [illegible] periodical fluctuations are [illegible] ing a thin plate of iron [illegible]

[illegible] it instantly occurred to me [illegible] would be less injurious. [illegible]

thought that I was able to [illegible] portions of the body, but it is certain however, that the [illegible] frequencies [illegible]

[illegible]

[illegible] portion of the [illegible] currents of high [illegible]

[illegible] be very well accepted [illegible] current, and the [illegible]

In regard to the sugg[illegible] Prof. Thomson mentions in another [illegible] issue of THE ELECTRICAL WORLD [illegible]

[illegible]

[illegible] cal remarks [illegible] remarks would be dicta[illegible] often we are forced [illegible] feelings of friendship and mutual consideration [illegible]

The Construction and Care of Electric Railroads—General Remarks on Line Construction.

BY ARTHUR K. [illegible]

This article consists largely of some general rules and formulas relative to the amount of power lost in overcoming the resistance of the trolley and feed wires, the locating of the poles, together with various other items which may prove useful to the constructor. The power which may be [illegible] to be lost in this manner [illegible] spent in [illegible] the conductors, and is easily [illegible] by the formula,

$$\frac{C^2 R}{746} = \text{the horse power lost}$$

The resistance of a copper wire [illegible] expressed by the formula 32.27 times its length [illegible] vided by the square of its diameter in thousandths of an inch, and for other metals the resistance may be found [illegible] the constant being changed according [illegible]

[illegible]

Where feed wires are run in connection with the [illegible] lines, and are cross connected with them at short distances, the joint resistance may be considered as that of a conductor whose resistance is equal [illegible] several resistances divided by their [illegible] power calculated in the same manner as it would [illegible] wire. The loss permissible on a line depends on the grade and cost of power. In most cases, when [illegible] reasonable, it is about 25 per cent. of the total [illegible] developed by the generators, and on grades it should be much less, the current being supplied at these points by separate feed wire, and a circuit-breaker being put in the trolley lines at the top and bottom of the hill, [illegible] one, and if it is sufficiently long to warrant it, the line should be again broken in the centre of the grade. The object of this is to protect the rest of the system, [illegible] any car motor burn out or the line because [illegible] through defective car wiring, the insulation of which [illegible] be liable to give way and ground the line when [illegible] to heavy service on grades.

The weight of copper wire [illegible]

[illegible]

[illegible]

[illegible] the insulated [illegible] part of the pole [illegible]

[illegible] symmetrical [illegible]

In wire construction a [illegible] end of the curve [illegible] precise point for the [illegible] Fig. 3. A line with the [illegible] to the front dashboard [illegible] tween these lines. The [illegible] lines 1 and 2 stand on the inside [illegible]

[illegible]

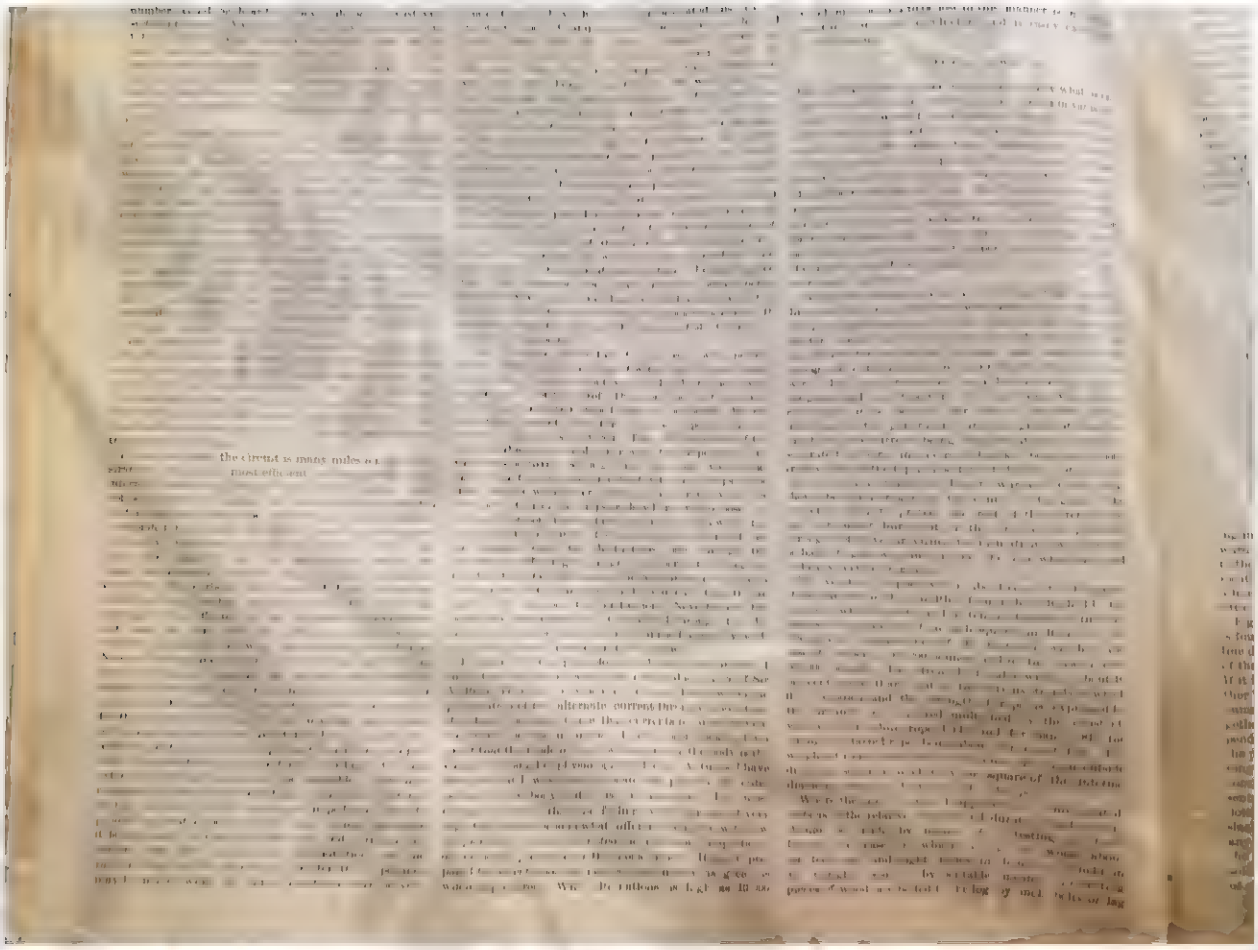
ing in line with them at the [illegible] location should be fixed at [illegible] a line drawn parallel to the [illegible] Fig. 4 shows the correct [illegible] is found by an equilateral [illegible] line drawn between the last two [illegible] of the curve [illegible]

[illegible] cumstances may require [illegible] gether at this point [illegible] the points 5 and F, and [illegible] construction poles should [illegible] centre and a span wire [illegible] dotted lines, the object being [illegible] slack from coming back [illegible]

The Construction and Care of Electric Railroads II

General Remarks on Line Construction etc

BY ARTHUR WRIGHT



Phenomena of Alternating Currents of Very High Frequency

BY NIKOLA TESLA

I am glad, as well as surprised, to see that Prof. Thomson, in THE ELECTRICAL WORLD AND ENGINEER of January 16, 1892, has been induced to publish his views on the phenomena of alternating currents of very high frequency, as they have been developed in the course of my investigations. Although I have always tried to encourage in every way the publication of experimental results, I must confess that I was not a little surprised when I saw that some of his statements referred to my own work.

I am not disposed to imply that whatever work Prof. Thomson undertakes in alternating currents of very high frequency is not of value. It is to be regretted, however, that he has not published the full particulars of his experiments, although I presume that even preliminary results of the experiments he has referred to would be of great interest to the scientific world. It is doubtful whether, in the absence of any publication on the part of the persons referred to, a correct conception can be formed of the most advanced work in this direction. Now that I have indicated the existence of this field, I will probably follow suit for the very purpose of showing some of the results I have reached.

Prof. Thomson states decisively in regard to the experiment with the incandescent lamp built in the manner I mention that a single wire is sufficient, and that conduction through the glass has nothing to do with the phenomenon observed. He says: "It is a well-known fact that a glass globe has practically no dielectric strength." I do not think that Prof. Thomson will maintain his position in this respect when I tell him that I have operated lamps in which the glass was in contact with the conducting coating on the outside, and that I have frequently observed the glass to be pierced by the discharge. Of course, I am speaking of lamps which have been in use for some time, as a new lamp will stand enormous electrostatic strains. Many people seem to be under the impression that the glass of the bulb is a perfect insulator, which is a false inference.

I have not made any statements in regard to the action of the lamp when connected to a single wire, as I have not had the time to experiment in this direction. I have, however, observed that the lamp will operate when connected to a single wire, and that the glass will become heated, but not to the same degree as when the lamp is connected to both wires of the circuit. I have also observed that the glass will become heated when the lamp is connected to a single wire, and that the glass will become heated when the lamp is connected to both wires of the circuit. I have also observed that the glass will become heated when the lamp is connected to a single wire, and that the glass will become heated when the lamp is connected to both wires of the circuit.

Prof. Thomson further states in regard to my views upon the regard to the capacity [illegible] that five or six years ago it occurred to me that the [illegible] of the armature coils were of a high [illegible] that of comparatively short wire [illegible] the voltage [illegible] in a dense magnetic field. [illegible] to the [illegible] and to the [illegible] I [illegible] that [illegible] would [illegible] a considerable [illegible] of wire and connected [illegible] circuit with the armature coil. He thus [illegible] thought the property of [illegible] and that along with efficient motor generation Prof. Thomson [illegible] he expected the possibly [illegible] effects would be very much [illegible] so as to [illegible] regularly instrumental [illegible] wave-[illegible] and as [illegible] to Prof. Thomson I would say that to expect a good result from such a combination was rather sanguine. Earth is not far from Heaven than this arrangement is from [illegible] which there would be a length [illegible] give the same self-induction [illegible] the armature [illegible] I [illegible] M. F. instead of [illegible] Prof. Thomson [illegible] that this [illegible] must be better [illegible] where [illegible] the [illegible] I [illegible] the necessary [illegible]

Prof. Thomson [illegible] the [illegible] of [illegible] perfect [illegible] current. Now [illegible] not [illegible] subject, but, if anything

it renders the undulation ... is self-evident. Let us insert a self-inductive coil in a circuit traversed by an undulating current of ... which happens. During the period of the greatest rate when the current has a small value the self-... opposes more than during the time of the ... and when the current is at or near its maximum ... is that with the same frequency ... the maximum value of the current becomes the greater, the greater the self-induction. As the sound ... is ... audible only on the maximum value it is clear that self-induction is the very thing required in a telephonic circuit. The ... the self-induction in the louder and clearer the sound. I have had the same current to pass through the coil ... during my telephone experience of several years. As regards the fact that a self-inductive coil in a wire with a telephone diminishes the loudness of the sound, Prof. Thomson seems to overlook that this effect is wholly due to the impedance of the coil, *i. e.*, to its virtue of diminishing the current-strength. But while the current-strength is diminished the undulation is rendered only more pronounced. Obviously, when comparisons are made they must be made with the same current.

In an arc machine such as that of Prof. Thomson's the effect is different. There one has to deal with a make and break. There are then two induced currents, one in the opposite, the other in the same direction with the main current. If the function of the mechanism be the same whether self-induction coil be present or not the undulations could not possibly be wiped out. But Prof. Thomson likewise to forget that the effect is wholly due to the ... of the commutator, namely, the induced current of ... which is of the same direction with the main ... and of great intensity when large self-inductive ... momentarily bridges the adjacent commutator segments ... if not entirely so, at least shortens the interval during which the circuit is open and thus reduces the undulations.

In regard to the improvement in the feeding of the ... Prof. Thomson ... that the vibrating ... work ... He ... with ...

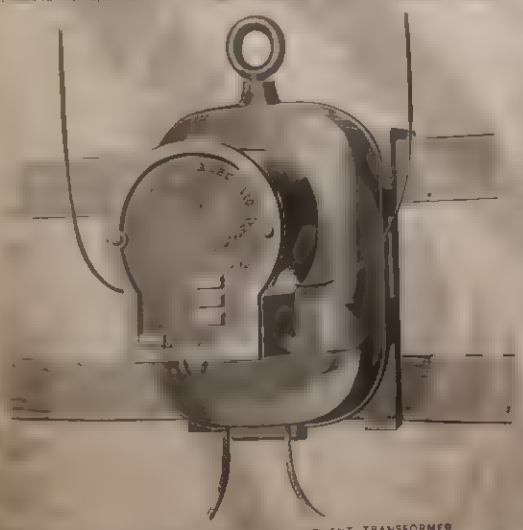


FIG. 1 STANLEY ALTERNATING CURRENT TRANSFORMER

... statements ... workmanship ... is regular ... by tests ... whether ... the ... down ... and current ... the ... and wind ... gives a better result. Of

... not consider the ... Jackson ... section published ... Sir William Thomson ... the ... substance of the tests ... assume either condensers ... from the ... the line.

* * *

... component parts of the system have been ... and ... operated by an ... efficient type ... of the most ... description. It has taken some years of experimental ... with alternating ... to ... present high state of efficiency ... and the other necessary ... of the alternating system, that ... is, the secondary generator ... the transformer ... has gone through ... somewhat ... the same slow process ... of evolution. In the early stages of the art the transformer was modified out ... two ... of the very latest ... manufactured by the Stanley Electric Manufacturing Company from the designs of Mr. William Stanley, Jr., who has become so widely known through his connection with the rise and development of the Westinghouse system. Many of the fundamental patents of this company are the ... of his genius. In the transformer that he has just designed and put on the market there are no moving ... changes ... working ... types ... of ...

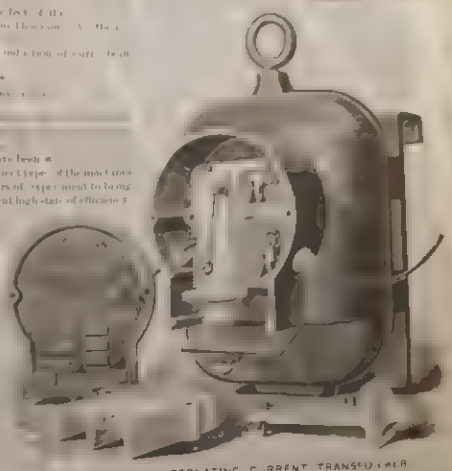


FIG. 2 STANLEY ALTERNATING CURRENT TRANSFORMER

Annual Report of the American Telephone Company

The annual report of the ... company for the year ending Dec. 31 ...

a third load instead of
A condenser takes a
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ed of 33 ampères in step
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Alternating constant currents have, however, one advantage over direct that I think is not realized. Synchronizing motors will run perfectly on series constant-current circuits; and as they run at constant speed, there is no racing, or trouble about governing, as in the case of direct currents. Of course, constant speed of engine is here necessary to give constant frequency. Many people seem to have gathered from Dr. Hopkinson's paper that series alternating motors will not run; but this is a false inference.

Phenomena of Alternating Currents of Very High Frequency.

BY NIKOLA TESLA.

I cannot pass without comment the note of Prof. Thomson in THE ELECTRICAL WORLD of April 4, although I dislike very much to engage in a prolonged controversy. I would gladly let Prof. Thomson have the last word, were it not that some of his statements render a reply from me necessary.

I did not mean to imply that whatever work Prof. Thomson has done in alternating currents of very high frequency was subsequent to his letter published in *The Electrician*. I thought it possible, and even probable, that he had made his experiments some time before, and my statement in regard to this was meant in this general way. It is more than probable that quite a number of experimenters have built such machines and observed effects similar to those described by Prof. Thomson. It is doubtful, however, whether, in the absence of any publication on this subject, the luminous phenomena described by me have been observed by others, the more so as very few would be likely to go to the trouble I did, and I would myself not have done so had I not had an advance of firm conviction gained from the study of the works of the most advanced thinkers that I would obtain the results sought for. Now that I have indicated the direction, many will probably follow, and for this very purpose I have shown some of the results I have reached.

Prof. Thomson states decisively in regard to the experiment with the incandescent lamp bulb and the filament mounted on a single wire that he cannot agree with me at all that conduction through the glass has anything to do with the phenomenon observed. He mentions the well-known fact that an incandescent lamp acts as a Leyden jar and says that "if conduction through the glass were a possibility this action could not occur." I think I may confidently assert that very few electricians will share this view. For the possibility of the condenser effect taking place it is only necessary that the rate at which the

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Prof. Thomson seems to think [illegible]
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think that [illegible] such a thing as a perfect [illegible]
among the [illegible] we are able to procure. [illegible]
think that as regards conduction there can be [illegible]
of degree? If glass were a perfect [illegible]
could we account for the conduction through [illegible]
degree [illegible] proved to exist by differences of potential?

While not directly connected with the present discussion, I would here point out that there exists a popular error in regard to the properties of dielectric bodies. Many electricians frequently confound the theoretical conception of Maxwell with the dielectric bodies in use. They do not stop to think that the only perfect dielectric is the ether, and that all other bodies, the existence of which is known to us, must be conductors, judging from their physical properties.

My statement that conduction is concerned to some although perhaps negligible, extent in the experiment above described was, however, made not only on account of the fact that all bodies conduct more or less, but principally on account of the heating of the glass during the experiment. Prof Thomson seems to overlook the fact that the insulating power of glass diminishes enormously with the increase in temperature, so much so that melted glass is comparatively an excellent conductor. I have, moreover, stated in my first reply to Prof Thomson in THE ELECTRICAL WORLD of March 21, 1891, that the same experiment can be performed by means of an unvarying difference of potential. In this case it must be assumed that some such process as conduction through the glass takes place, and all the more as it is possible to show by experiment that with a sufficiently high steady difference of potential enough current can be passed through the glass of a condenser with mercury coatings to light up a Geissler tube joined in series with the condenser. When the potential is alternating the condenser action comes in, and conduction becomes insignificant, and the more so the greater the rate of alternation or change per unit of time. Nevertheless, in my opinion, conduction must always exist, especially if the glass is hot, although it may be negligible with very high frequencies.

Prof. Thomson states further that, from his point of view, I have misunderstood his statement about the limit

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Prof. Thomson states further that, from his point of view, I have misunderstood his statement about the limit of audition. He says that 10,000 to 20,000 alternations correspond to 5,000 to 10,000 complete waves of sound. In my first reply to Prof. Thomson's remarks in THE ELECTRICAL WORLD of March 21, 1891, I avoided pointing out directly that Prof. Thomson was mistaken, but now I see no way out of it. Prof. Thomson will pardon me if I call his attention to the fact he seems to disregard, namely, that 10,000 to 20,000 alternations of current in an arc—which was the subject under discussion—does not mean 5,000 to 10,000, but 10,000 to 20,000 *complete waves of sound*.

He says that I have adopted or suggested as the limit of audition 10,000 waves per second; but I have neither adopted nor suggested it. Prof. Thomson states that I have been working with 5,000 to 10,000 complete waves while I have nowhere made any such statement. He says that this would be working below the limit of audition, and cites as an argument that at the Central High School in Philadelphia he has heard 20,000 waves per second; but he wholly overlooks a point on which I have dwelt at some length—namely, that the limit of audition of an arc is something entirely different from the limit of audition in general.

Prof. Thomson further states, in reply to some of my views expressed in regard to the constant current machines, that five or six years ago it occurred to him to try the construction of a dynamo for constant current, in which "the armature coils were of a highly efficient type, that is, of comparatively short wire length for the voltage and moving in a dense magnetic field." Exteriorly to the coils and to the field he had placed in the circuit of each coil an impedance coil which consisted of an iron core wound with a considerable length of wire and connected directly in circuit with the armature coil. He thus obtained, he thought, "the property of considerable self induction along with efficient current generation." Prof. Thomson says he expected "that possibly the effects would be very much the same as those obtainable from the regularly constructed apparatus." But he was *disappointed*, he adds. With all the consideration due to Prof. Thomson I would say that to expect a good result from such a combination was rather sanguine. Earth is not farther from Heaven than this arrangement is

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Prof. Thomson seems to think that self-induction wipes out the periodical undulations of current. Now self-induction does not produce any such affect, but, if anything,

it renders the undulations more pronounced. This is self-evident Let us insert a self-induction coil in a circuit traversed by an undulating current and see what happens. During the period of the greatest rate of change when the current has a small value, the self-induction opposes more than during the time of the small rate of change and when the current is at or near its maximum value. The consequence is that with the same frequency the maximum value of the current becomes the greater, the greater the self-induction. As the sound in a telephone depends only on the maximum value it is clear that self-induction is the very thing required in a telephone circuit. The larger the self-induction the louder and clearer the speech, provided the same current is passed through the circuit. I have had ample opportunity to study this subject during my telephone experience of several years. As regards the fact that a self-induction coil in series with a telephone diminishes the loudness of the sound, Prof. Thomson seems to overlook that this effect is wholly due to the impedance of the coil, *i. e.*, to its virtue of diminishing the *current's strength*. But while the current's strength is diminished the undulation is rendered only more pronounced. Obviously, when comparisons are made they must be made with the same current.

In an arc machine such as that of Prof. Thomson's the effect is different. There one has to deal with a make and break. There are then two induced currents, one in the opposite the other in the same direction with the main current. If the function of the mechanism be the same, whether self-induction coil be present or not, the undulations could not possibly be wiped out But Prof. Thomson seems likewise to forget that the effect is wholly due to the defect of the commutator; namely, the induced current of break—which is of the same direction with the main current and of great intensity when large self-induction is present—simply bridges the adjacent commutator segments, or if not entirely so, at least shortens the interval during which the circuit is open and thus reduces the undulation.

In regard to the improvement in the feeding of the lamps by vibration or undulations, Prof. Thomson expresses a decisive opinion. He now says that the vibrations *must* improve the feeding of a clockwork lamp. He says that I "contented myself by simply saying" that I cannot agree with him on that point.

Now, *saying it* is not the only thing I did. I have passed many a night watching a lamp feed, and I leave it to any skilled experimenter to investigate whether my

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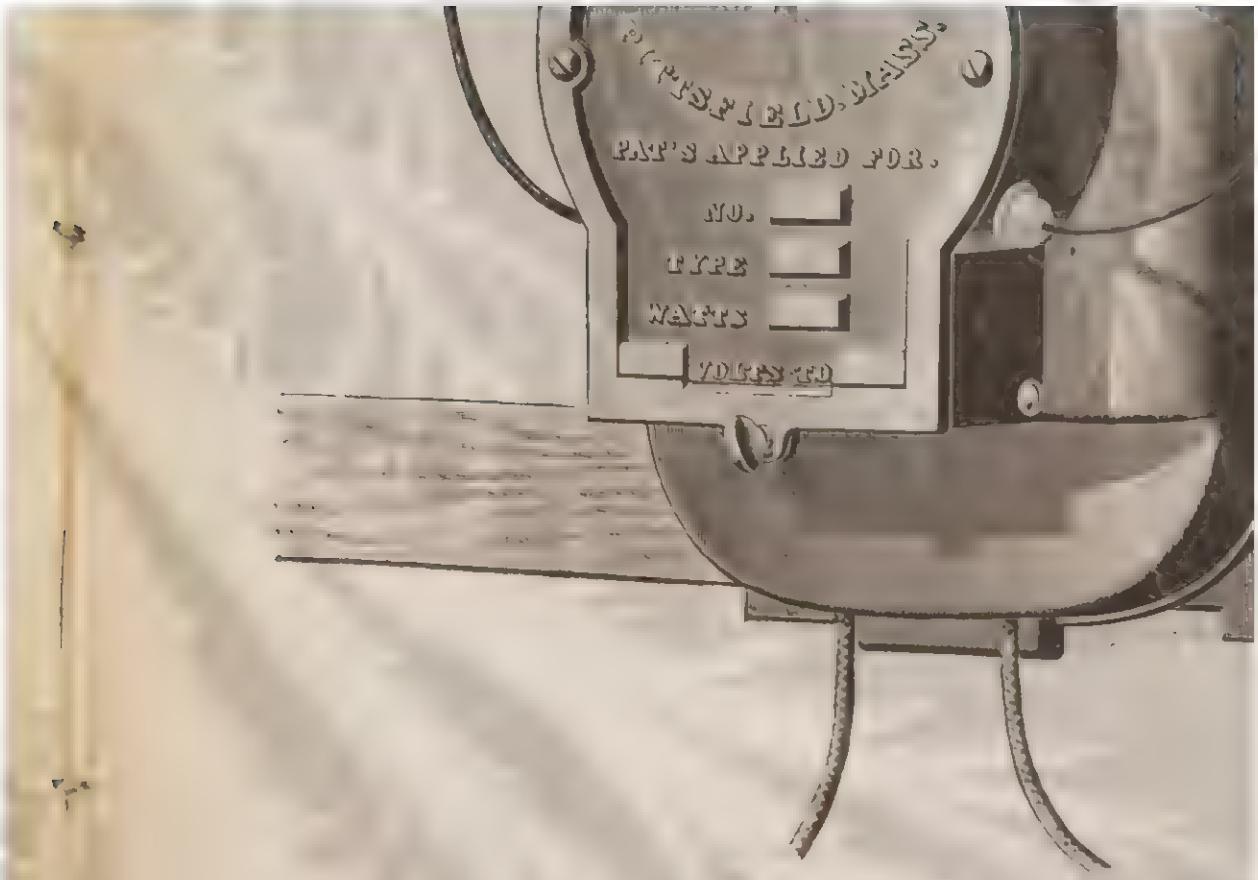

FIG. 1.—STANLEY ALTERNATING CURRENT TR

statements are correct. My opinion is that a clockwork lamp - that is, a lamp in which the descent of the carbon is regulated not by a clutch or friction mechanism, but by an escapement—cannot feed any more perfectly than tooth by tooth, which may be a movement of, say, one-sixty-fourth of an inch or less. Such a lamp will feed in nearly the same manner, whether the current be perfectly smoo h or undulating, provided the conditions of the circuit are otherwise stable. If there is any advantage I think it would be in the use of a smooth current, for with an undulating current the lamp is likely to miss some time and feed by more than one toot'i. But in a lamp in which the descent of the carbon is regulated by friction mechanism, an undulating current of the proper number of undulations per second will always give a better result. Of

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course to realize fully the benefits of the undulating current the release ought to be effected independently of the up and down movement, as I have pointed out before.

In regard to the physiological effects Prof. Thomson says that in such a comparatively poor conductive material as animal tissue the distribution of current cannot be governed by self-induction to any appreciable extent, but he does not consider the two-fold effect of the large cross-section pointed out by Sir William Thomson. As the resistance of the body to such currents is low, we must assume either condenser action or induction of currents in the body.

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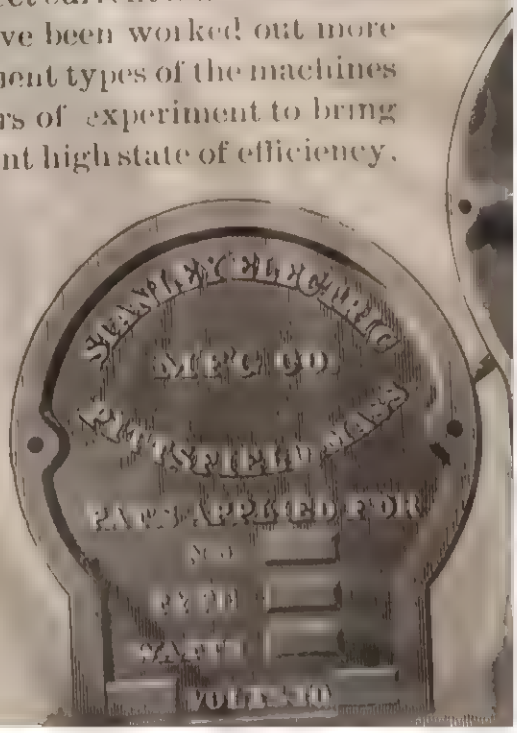
The Stanley Transformer.

As alternating current apparatus has come into more and more general use it has gone through the same stages of evolution as has characterized direct current machines. The component parts of the system have been worked out more and more carefully, and more efficient types of the machines designed. It has taken some years of experiment to bring the alternating dynamo to its present high state of efficiency, and the other necessary part of the alternating system, that is, the secondary generator—the transformer—has gone through somewhat the same slow process of evolution. In the early stages of the art the transformer was inefficient and regulated badly. It was improperly designed and often poorly built. Gradually the principles involved in its con-



Text of speech for the Institute of Immigrant
Welfare

Hotel Biltmore, May 12, 1938

Would not present to receive honorary citation.

From: Dr. Nikola Tesla.

Mr. Ch[illegible],
[illegible] of [illegible]
Ladies and Gent[illegible]

-Migrant Welfare,

I can not fi[illegible] to express adequately my keen regret for being un[illegible], in person, the high distinction which the Insti[illegible] Welfare [illegible]. Although my recovery from [illegible] months ago is al[illegible] to, I do not feel equal to the task of appearing in public and [illegible] ating the obligations which this would impose upon me.

My coming to this country was a great adventure -- every detail of which is still vivid in my memory. Early in 1884, while employed by a French Company in Paris, France, I made important improvements in dynamos and motors and was engaged by the Edison interests in New York to design and construct similar machines for them. It had been the height of my ambition and my most ardent wish to come in contact with Edison and see America. Accordingly, I undertook the voyage and after losing my money and tickets and passing through a series of mishaps, including a mutiny in which I nearly lost my life, I landed on these blessed shores with four cents in my pocket. My first intention was to look up a close American friend before going to the Edison establishment. On my way uptown I came to a small machine shop in which the foreman was trying to repair an electric machine of European make. He had just given up the task as hopeless and I undertook to put it in order without a thought of any compensation. It was not easy but I finally had it in perfect running condition. I was astonished when he gave me twenty dollars and wished that I had come to America years before. The next day I was thrilled to the marrow by meeting Edison who began my American education right then and there. I wanted to have my shoes shined, something I considered below my dignity. Edison said: "Tesla, you will shine the shoes yourself and like it. He impressed me tremendously. I shined my shoes and liked it.

I began the work for which I was engaged immediately and after nine months of strenuous effort I fulfilled my contract rigorously. The manager had promised me fifty thousand dollars but when I demanded payment, he merely laughed. "You are still a Parisian," remarked Edison, "when you become a full-fledged American you will appreciate an American joke." I felt deeply hurt as I had expected to use the money in the development of my alternating system and when some people proposed to form a company under my name, I accepted eagerly. Here as the opportunity I had vainly sought for years but my new friends were adamant in their resolve not to have anything to do with the worthless alternating currents which Edison condemned as deadly. They desired an arclight system and I had to comply with their request though the delay of my cherished plans was agonizing. In one year of day and night application, I managed to perfect the system which was adopted for lighting the city and some factories in the neighborhood. Then came the hardest blow I ever received. Through some local influences, I was forced out of the company losing not only all my interest but also my reputation as engineer and inventor. After that I lived through a year of terrible heartaches and bitter tears, my suffering being intensified by

[illegible] to work as a laborer [illegible] science, mechanics and fortune o[illegible]. Finally, I had the good and c[illegible] to m[illegible]. [illegible] honest man who listened to me laboratory and [illegible] a moment but [illegible] financial support. I perfected my moto[illegible] quickly h[illegible]ving nothing else to do except to carry out plans I [illegible] formed years before. My inventions proved a success and attracted the attention of George Westinghouse. He was, in my opinion, the only man on this globe who could take up the battle against [illegible] the circumstances then existing and win of imposing stature, one of the world's true noblemen of whom America may well be proud and to whom humanity owes an immense debt of gratitude.

I have to add that in all my troubles I did not neglect to declare my intention of becoming a citizen of this glorious country and in due course I secured my papers making me a proud and happy man.

Nikola Tesla

S-28
April or May, 1938

From: Dr. Nikola Tesla

Mr. Chairman,
Members of the Institute of Immigrant Welfare,
Ladies and Gentlemen:

I can not find words to express adequately my keen regret for being unable to receive, in person, the high distinction which the Institute of Immigrant Welfare has conferred upon me. Although my recovery from injuries sustained in an automobile accident six months ago is almost complete, I do not feel equal to the task of appearing in public and meeting the obligations which this would impose upon me.

My coming to this country was a great adventure -- every detail of which is still vivid in my memory. Early in 1884, while employed by a French Company in Paris, France, I made important improvements in dynamos and motors and was engaged by the Edison interests in New York to design and construct similar machines for them. It had been the height of my ambition and my most ardent wish to come in contact with Edison and see America. Accordingly, I undertook the voyage and after losing my money and tickets and passing through a series of mishaps, including a mutiny in which I nearly lost my life, I landed on these blessed shores with four cents in my pocket. My first intention was to look up a close American friend before going to the Edison establishment. On my way uptown I cam to a small machine shop in which the foreman was trying to repair an electric machine of European make. He had just given up the task as hopeless and I undertook to put it in order without a thought of any compensation. It was not easy but I finally had it in perfect running condition. I was astonished when he gave me twenty dollars and wished that I had come to America years before. The next day I was thrilled to the marrow by meeting Edison who began my American education right then and there. I wanted to have my shoes shined, something I considered below my dignity. Edison said: "Tesla, you will shine the shoes yourself and like it. He impressed me tremendously. I shined my shoes and liked it.

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material want. Very often I was compelled to work as a laborer and my high education in various branches of science, mechanics and literature seemed to me like a mockery. Finally, I had the good fortune of meeting two capable and honest men who listened to me and came to my assistance. They organized a company, provided a laboratory and gave me a modest but sure financial support. I perfected my motors quickly having nothing else to do except to carry out plans I had formed years before. My inventions proved a success and attracted the attention of George Westinghouse. He was, in my opinion, the only man on this globe who could take my alternating system under the circumstances then existing and win the battle against prejudice and money power. He was a pioneer of imposing stature, one of the world's true noblemen of whom America may well be proud and to whom humanity owes an immense debt of gratitude.

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